RADIOLOGY

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Superficial "Burns" of Skin and Eyes from Scattered Cathode Rays[1]

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THE PRESENT report is concerned with varying degrees of injury received by six men in the Department of Radiology at the Massachusetts General Hospital as a result of a few seconds' exposure to scattered electrons from a 1,200-kv. electrostatic generator. The main purpose in presenting this report is to prevent a repetition of that experience. It seems important also to emphasize the dangers inherent in scattered as well as in direct cathode rays, in order that the recurrent enthusiasm for their therapeutic possibilities may not be permitted to overshadow their possible harmful effects.

Reports of serious radiation injury to persons working with roentgen-ray generators are uncommon at the present time, although in the early days of roentgenology such reports were common. Those trained in the use of the roentgen ray have a definite respect for its latent injurious effects, and it is to be noted that relatively few radiation injuries are seen in this group. Most of the injuries which have occurred have been due to lack of training. In retrospect, therefore, the question arose as to whether an accident such as occurred in this hospital is excusable, whether all the possible dangers associated with cathode rays should have been appreciated by at least the senior members of the group. The effect of exposure to cathode rays in the direct beam was of course known (9, 10), but the effect of scattered cathode rays was not understood. The scattering was thought to be similar to the fluorescence of ionized air which is visible beneath the cathode ray port in a dark room (Fig. 1). Subsequent careful review of the medical literature has failed to reveal any reports of injuries due to scattered cathode rays. Numerous articles have dealt with the physical and the biologic aspects of these rays, a few with their use in the treatment of certain skin diseases, but only a rare publication has mentioned accidental injury due to them.

Jacobsen and Waddell (7) found that the effects of cathode rays on the skin of the rat were similar to those of roentgen rays, and that actually the effect of the

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Fig. 1. Photograph of the fluorescence of ionized air produced by a 3,000-kv. electrostatic generator. (The machine in use at this hospital is a 1,200-kv. generator.)

roentgen rays was due to cathode rays which originated in the tissues. Jacobsen (6) later confirmed these observations by experiments on the skin and testis of the white rat. Brasch (2) reported experiments on white mice and rabbits made in the direct beam with cathode rays generated at 2,500 kv., 1 ma., at 100 cm. distance. The mice died a few days after exposures of 1/10,000 to 1/1,000,000 second. These observations indicate that the effects of cathode and roentgen rays are similar, except that the former have a definite and limited depth of penetration without underlying reaction.

Wilhelmy (11), using cathode rays energized at approximately 210 kv., 1 ma., and a treatment distance of 5 cm., was able to produce an erythema with 1/2 second exposure. With this dosage, no epilation was observed. With 400 times the threshold erythema dose, two definite reactions were noted, the first appearing almost immediately and the later or main reaction developing about thirty-five days after irradiation. Wilhelmy observed likewise that areas irradiated with cathode rays showed relatively little if any pigmentation, whereas those receiving treatment with roentgen rays showed characteristic pigmentation and telangiectasis. He believed that the effects of the two types of radiation were in the main similar and that any differences were due to the limited depth of penetration of the cathode ray.

In 1934, Brasch and Lange (3) experimented with cathode rays generated at voltages up to 3,000 kv. Their investigations indicated that damage due to overdosage from cathode rays was similar to that following roentgen irradiation. Summarizing the results of their work, they stressed the following essential characteristics of cathode rays: (1) limitation to a defined depth of penetration, (2) ability to transmit more energy to the depth than to the surface, (3) marked biologic effect, and (4) deflectability by magnets.

Baensch and Finsterbusch (1) reported the results of treatment with cathode rays in a few selected cases of lupus, psoriasis, poorly healing superficial lesions, eczema, and cancer. They mention the necessity of protection for the eyes to avoid irradiation of the conjunctiva and cornea. From their experiments they concluded that cathode rays have a remarkable power of healing in a number of skin lesions, but they also warn that considerable reaction usually follows this form of treatment. They state that a sufficient number of cases had not been treated to warrant drawing definite conclusions as to the types of lesions that would respond most satisfactorily.

Crawford (4) in 1933 reported an instance of injury from cathode rays. A review of the case history suggests that the injured physicist was within the direct beam, and Crawford himself states that the condition may have been complicated by the fact that a "Willemite" screen was

used. In this case a rather prompt erythema with edema appeared, and later bullae developed on the fingers. The original reaction healed in four weeks. The patient was followed for ten months, and at the time of the report showed numerous areas of telangiectasis with dryness and slight thinning of the cutis.

An unreported accident that occurred in 1935 was recently called to our attention. A physicist, working with a unit of construction and type similar to the one in use at this hospital, received injuries along the volar surface of the forearm and the inner surface of the arm, as well as some damage to several fingers. The injury to the forearm and arm could have been due to roentgen rays, as the extremity partially encircled a brass pipe which conducted the electrons from the tube to the target. The burns on the fingers, however, may well have been caused by exposure to cathode rays. Today, ten years after the injury was received, the scars of these burns show telangiectasis, skin atrophy, and lack of pigmentation, and are similar to the late changes following exposure to roentgen rays or radium. After the accident, this physicist made numerous experiments with cathode rays and became fully aware of the manner in which the electrons scatter as well as the means of protection, but unfortunately this material was not published in the medical literature.

An unconfirmed verbal report has it that several years ago a group of persons in Russia were exposed to cathode rays and received skin injuries. We have been unable, however, to find any published account of the incident detailing the exact means of exposure, the severity of the reactions, or the amount of permanent damage.

The majority of the publications on cathode rays are confined to experiments or therapeutic procedures carried out in the direct beam and give no definite information regarding the effect of scattered electrons. The energy involved in cathode rays is many times greater than that of roentgen rays. This is more readily understood when it is realized that in the production of the latter probably only 0.5 per cent of the energy of the electron stream is converted into x-rays. It seems likely that the effect in the tissues superficial to the depth penetrated by cathode rays is similar to that of x-rays, as experiments have shown that the biologic effect of the latter is dependent upon the effect of cathode rays generated within the tissue.

Our experience with cathode rays is essentially in agreement with that of the various investigators referred to above.

THE EXPOSURE TO SCATTERED CATHODE RAYS

On Dec. 1, 1944, in the supervoltage treatment room at this hospital, the target had been removed from the tube of the 1,200-kv. electrostatic generator, and the cathode-ray window inserted in its place. This procedure had been undertaken because the focal spot had been wandering and quick determinations of its size and location were desired in order to correct the error. The necessary information could be readily obtained by inserting a piece of film beneath the cathode-ray window and burning a hole in it with very short exposure.

It was known, of course, that there was definite danger from the direct beam, but it was thought that, if a reasonable distance were maintained, there was no great danger in entering the room for a short period of time. Consequently, a group of six men—a staff member (*E*), the physicist (*B*), two residents in radiology (*A* and *C*), and two medical students (*D* and *F*)—went into the room while the machine was in operation. The entire time during which the machine was running was probably not longer than two minutes. Each of the six persons stood at least 3 to 5 or more feet away from the central beam, and at right angles to it. At one point all of them leaned down and for five seconds or less looked up at the cathode ray window to observe its fluorescence. *A*, *B*, and *C* stood approximately in the posi-

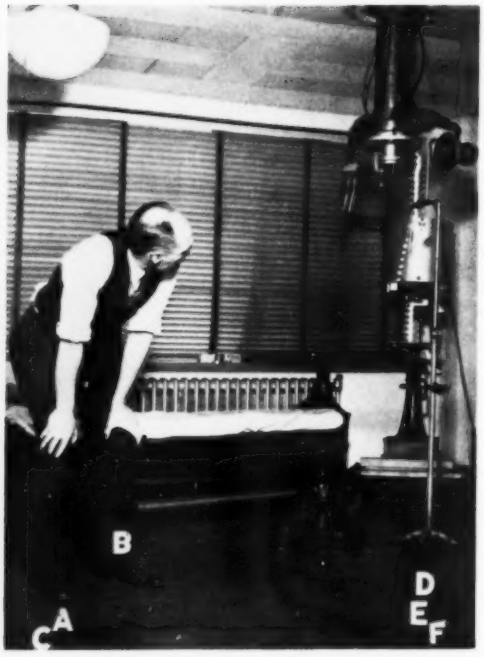


Fig. 2. The room as it appeared at the time of the accident. A, B, C, D, E, and F indicate the respective positions of the six men who were exposed to the cathode rays.

tion of the man in Figure 2; *D*, *E*, and *F* stood somewhat to the right and about the same distance away from the plane of the central beam. For an instantaneous period of time, *A* stepped considerably closer to the machine and pointed toward the cathode-ray window. He was immediately warned to stand back, and did so. (Whether or not during this instant he actually stepped into the direct beam is unknown. He undoubtedly received the most severe injuries of the entire group.) *A*, *C*, *D*, *E*, and *F* all left the room at the end of a period probably less than ten minutes and received no further irradiation. *B* had made two somewhat similar observations during the morning of the same day but was not in the room during the afternoon exposures to the scattered cathode rays.

EXTENT OF THE EXPOSURE

Ionization Measurements: Within a day or two of the accident it was realized that approximate ionization measurements should be obtained in order to estimate the dose and the depth of penetration of the radiation received by those who were in the room. Likewise, it was necessary to exclude roentgen rays as a cause of the already apparent reactions. Inasmuch as the machine had been reassembled and was being used for supervoltage roentgen therapy, these measurements were delayed until Dec. 14. As nearly as possible, the actual conditions prevailing when the accident occurred were reproduced.

The source of radiation was a vertical 1,200-kv. cathode ray beam emitted through an 0.005-cm. thick aluminum window in the tube, which was 175 cm. above the floor. The diameter of the beam is about 1 cm. as it exits from the tube, but this is increased considerably farther from the tube due to scattering of the beam by air molecules. Previous measurements (9) indicate that the 0.005-cm. aluminum window stops only a small percentage of the electrons, and the maximum range of 1,200-kv. electrons is 5.4 mm. in water, and probably 450 cm. in air.

An estimation of the beam current in use at the time those who entered the room were exposed was made by trying to reproduce the burning effect on a piece of x-ray film. It was thus estimated that the beam current was about 50 microamperes, but it is realized that the estimate may be in error by a factor of two.

Measurements of ionization intensity in a phantom were made to obtain the ionization dose expected in the tissue of those who were irradiated. The phantom was located at about face level, 70 cm. downward from the portal and 100 cm. sideways from the center of the beam, and turned on its side so that depth was measured from the side nearest the beam. A thin ionization chamber (9) with an upper surface of 0.002 cm. cellophane was used so that measurements could be made very near the surface. The back of this chamber becomes part of the phantom.

A curve of "tissue roentgens" (5) *vs.*

depth in the phantom is included (Chart I). This shows that the intensity diminishes rapidly beyond 1 mm. in depth until it is practically zero at 3.1 mm. Thus the intensity of x-rays is negligible, since there is little ionization beyond the range of the cathode rays.

The Victoreen r meter with 100-r chamber attached, turned sideways to the beam, gave the same reading, within 10 per cent,

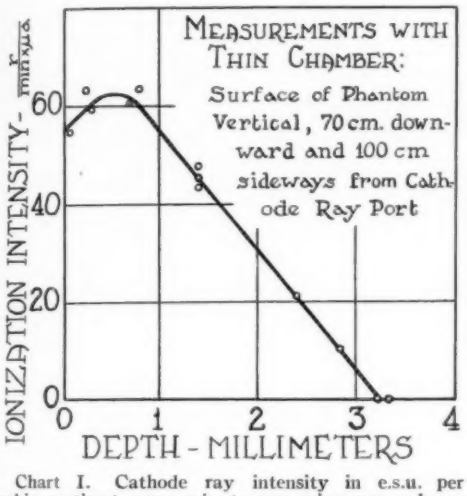


Chart I. Cathode ray intensity in e.s.u. per cubic centimeter per minute per microampere-beam current versus depth in phantom.

as the e.s.u. per cubic cm. in the thin chamber within 1 mm. of surface. Therefore, such Victoreen readings give skin dosage. Victoreen readings at various positions in the room are indicated on Chart II, the roentgens per minute per microampere-beam current being given by the numbers for the positions they occupy.

When a 5-mm.-thick lucite cap was placed over the Victoreen thimble the intensity was reduced to practically nothing, which indicated again that the x-ray intensity is very slight. Intensities in the beam of 11,000 r per minute per microampere were reduced by the cap to 0.28 r per minute per microampere, and at "B" (see Chart II), to one side of the main beam, the x-ray intensity was only 0.008 r per minute per microampere.

It is estimated that those who stood 100

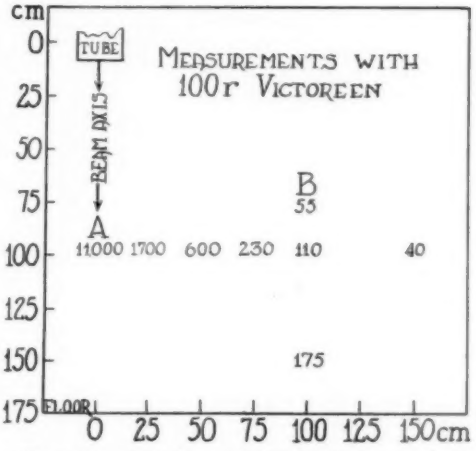


Chart II. Cathode ray intensity in r per minute per microampere-beam current versus position. With lucite cap, r at A = 0.28 and at B = 0.008.

cm. from the cathode port for 20 seconds received a skin dose of about 1,000 r on their faces and 2,000 r on their hands. The dosage on their feet would be greater except that this region was well protected by clothing. This estimate might be in error by a factor of two, due to the indeterminate beam current, and might be further in error due to the positions of the men, since the intensity increases very rapidly as one approaches the beam. The measurements also show that the effects will be limited entirely to the first 3 mm. below the surface and will be greatest in the first millimeter.

It seems logical to expect that the effect of a given tissue ionization dose will be the same for a 1,000-kv. cathode ray as for x-rays of similar wave length, since the ionization from x-rays is largely produced by secondary electrons with velocities approaching those of the electrons striking the target, and the damage to the tissues is also probably due to the effects of these electrons or the ions they produce. Thus the effect of cathode rays and of x-rays may be similar in regions receiving the same ionization dosage. It must be remembered, however, that the distribution of energy absorption in the body is very different for cathode rays from that for x-rays.

CLINICAL EFFECTS OF THE EXPOSURE

In spite of the short exposure, the burns were dramatic in appearance, and in three of the men had the unusual characteristic of showing three distinct phases. The first phase was superficial, was immediate or prompt in its appearance, and subsided in from five to seven days. It was followed by the secondary phase, with effects which were deeper, more widespread, and of longer duration. In some of the men these burns of the deeper tissues culminated in bleb formation and nearly complete loss of the epithelium. The third phase, appearing about four weeks after exposure, was characterized by much more extensive involvement and included a tertiary efflorescence which was widespread not only over new areas but also re-involving areas that had seemed to be healing from the secondary reaction.

During the exposure to cathode rays or immediately after leaving the room, the two fair-skinned men who wore no eyeglasses (*A* and *E*) noticed considerable irritation of the conjunctivae. At the moment, this was attributed to the large amount of ozone and the fact that film had been burning in the room. Two hours later, however, both men showed definite injection of the conjunctival vessels, with erythema of the face as well. Another man (*C*), who wore glasses, had a similar but less prompt and less intense effect. The conjunctival reaction subsided within three days.

By the next morning a superficial redness of the face and other exposed parts had developed which acted like the first extreme sunburn of the season. These effects were limited to the exposed areas, even a single layer of cotton cloth affording much protection. This first phase of the skin reaction was noted within four to thirty-six hours by all but one of the six men. This man (*F*) had a very dark olive skin; his first symptoms did not appear until eleven days after exposure, at the time the secondary phase became manifest in the others.

The first-phase reactions subsided in from five to seven days. The bright, deep red erythema faded to a dull red. Itching and a questionable tan appeared in the men with fair skin. The disappearance of the early reaction more or less merged into the secondary, deeper phase.

Approximately ten to twelve days after the exposure, the secondary phase was apparent in all of the group. It seemed to originate in the deeper tissues; the first evidence of its presence being noted as intense pain produced by shaving. This was not a superficial irritation, but gave the sensation of deeper pain, as when hairs are pulled out. One man (*A*) noticed the same deep tenderness in the nail beds of his hands, so that any use of the fingers, such as fastening a button, became an "almost impossible task." The tenderness was followed by a second increase in redness and edema of the involved parts and, in the more seriously affected cases, by blebs which contained clear fluid. The secondary phase lasted a varying length of time depending upon the severity of the burns. In the milder cases the tenderness disappeared after five to seven days, and shaving no longer caused pain. In three of the group this relief of tension occurred with crisis-like abruptness. In the more severe cases, reactions continued to appear in new areas which had been protected against the first phase by shirt, coat, trousers, or even shoes. One man (*A*) had pushed his dark adaptation red goggles up onto his forehead. These goggles were made of thin plastic material edged with leather binding. They completely protected his skin from the early phase of the burn, but directly below their lower margins the edema of the later secondary phase was marked (Color Plate I, 1-*a* to *e*).

Cytologic studies of the blood, made on the eleventh day after exposure, were normal in all the men.

Three weeks after the accident, three of the group (*D*, *E*, and *F*) had essentially recovered, and no subsequent reaction developed. *F*, a medical student, whose

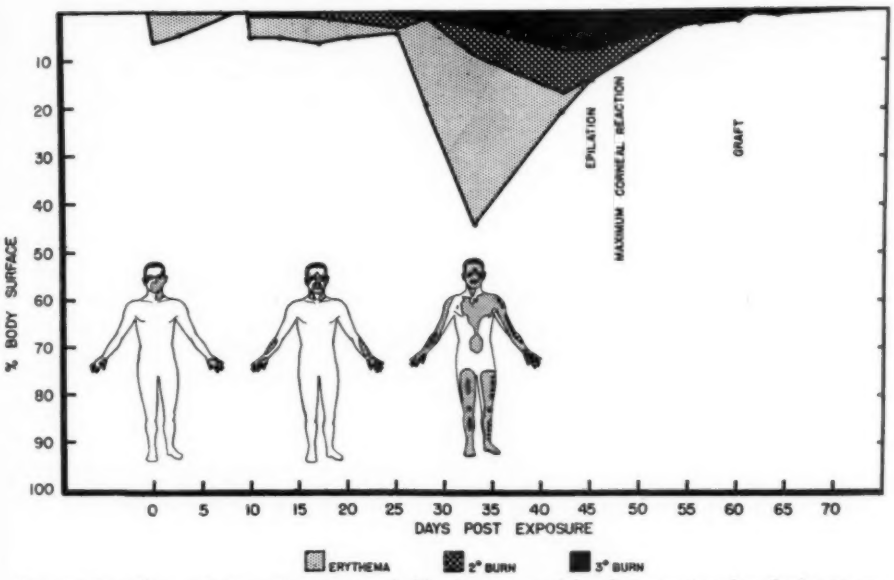


Fig. 3. Location, extent, and sequence of skin damage resulting from scattered cathode-ray exposure in Case A. The first phase, erythema only, started immediately after the exposure and had subsided before the appearance of the next phase. The second phase, first- and second-degree damage, started on the tenth day, and over it was superimposed the more extensive and deeper necrosis of the third phase.

peri-oral redness and edema had not appeared until the eleventh day and had subsided gradually, suffered the mildest reaction of the entire group. It seems highly probable that, although he was in the room a considerable length of time, two factors protected him. He stood farthest from the direct cathode beam and his complexion is extremely dark. *E*, a physician, had had marked edema of the eyelids and lips, erythema and deep tenderness of the face, and reddening of the skin over the chest. At the end of the second week, his first signs of improvement occurred within a half-hour's time, with a sudden release of the sensation of skin tension and deep pain. The entire reaction cleared up gradually during the third week. Although the immediate reaction in his eyes and the fair skin of his face had appeared to be the most severe of all, the secondary reaction was only moderate, and no tertiary phase was experienced. *D*, a medical student, having reached the peak of discomfort and disfigurement on the sixteenth day, made a rapid recovery. Some discoloration of the face, slight tanning of the skin of the neck and upper chest, and a certain amount of inelasticity and thickening of the involved areas were the only effects in evidence at the end of three weeks.

In the remaining three men a tertiary phase of the cathode-ray reactions appeared approximately four weeks after exposure. Areas that had been protected against the first and second phases by one or two layers of cloth became involved, proving that this protection had been inadequate in preventing the later and deeper reaction (Fig. 3).

In addition, earlier lesions which had seemed to be in the final stage of healing from the secondary reaction became re-involved, going on to deeper destruction. This was maximal in *A*, in whom second-degree burns of the arms, legs, and chest developed, and who showed a further necrosis of areas on the hands that had appeared to be healing (Color Plates I–III, 2-*a* to *i*, 3-*a* to *f*). These hand lesions progressed to third-degree burns of such ex-

tent that eventual grafting of the left was necessary. In this man the sequence of events was essentially as follows:

Four weeks after exposure, although some areas of reaction were subsiding, others were becoming progressively more involved. The lower eyelids became more blistered, and new areas of redness had appeared below the hairline on the neck, extending down over the chest, the shoulders, the full extent of both arms, and the anterior surface of both thighs and shins. Five weeks after exposure, new lesions appeared on the toes of the left foot and the whole front of the abdomen; the chest had become darkly red, and the deeper portions of the derma were exposed over large areas of the arms and legs. These new lesions appeared at the same time healing was apparent in other earlier involved areas, as the skin of the face, which by the end of seven weeks showed only a deep remaining flush. Thin plastic glasses had protected the skin of the forehead and the eyebrows. It was at this time that the second eye involvement became manifest (see Ophthalmologic Observations, below).

Physicist B had practically recovered so far as his face was concerned at the end of three weeks (Color Plate III, 4-*a* to *c*). The dorsum of each hand, particularly the right, which had showed the erythema of the first phase and secondary re-involvement on the eleventh day, became much worse on the eighteenth day. The skin of both hands was desquamating by the twenty-first day, although there had been no blistering of the left hand. A band of normal skin on the fourth left finger, which had been protected by a wedding ring, stood out in contrast to the adjoining areas of edema and redness. By the beginning of the fifth week, as the hands were healing, an erythema appeared over the anterior chest, shoulders, and upper arms, areas which had not hitherto shown changes (Color Plate III, 4-*d*). Blisters and crusting developed over the shoulders.

In the case of *physician C*, the third patient to show the tertiary phase, an erythema at the base of the neck and over the upper sternum appeared on the thirtieth day. At this time, the face and hands were nearly healed. Three days later a painful, tender erythema developed over the anterior surface of the knees; the discomfort persisted for a week with some desquamation and discoloration. At the end of two weeks the knee areas were again comfortable.

At the present time, six months after exposure, only one of the group, *A*, shows any noticeable evidence of injury.

The *treatment* employed was protection of the wounds by simple dressings and splinting, and to one patient (*A*) penicillin was administered. The erythema of the first phase seemingly required no treatment; none was carried out. The deeper disturbance of the second phase, on the other hand, was painful, and some relief was obtained by the general application of bland base ointments of either lanolin or petrolatum. When blebs appeared on the dorsum of the hands of three of the patients during the later (secondary) phase, gauze dressings with moderate pressure and splints were applied over the ointment. Effort was made to prevent bacterial contamination by keeping the bleb roofs intact. The bleb fluid in two of the men (*B* and *C*) remained clear and there was no clinical evidence of infection. Prompt healing proceeded beneath the blebs as evidence of the reaction elsewhere subsided.

In one patient who later developed full-thickness destruction of the skin (*A*), the blebs which started in the secondary phase became more extensive and ruptured with the introduction of the third phase. Because of the increasing depth of destruction and the lack of epidermal protection, this patient was hospitalized on the seventeenth day after exposure. The transudate from the wounds became purulent, and both a virulent staphylococcus and a non-pathogenic staphylococcus, typical of the normal skin flora, were obtained on culture. Penicillin was therefore administered intramuscularly, starting on the

twenty-first day, and was continued until three days before grafting, on the fifty-sixth day.

There was a striking absence of clinical evidence of infection in *A*, in spite of the presence on the wound surface of the virulent staphylococcus. The organism when first recovered was penicillin-sensitive, and it is therefore possible that the penicillin was helpful in preventing invasive sepsis of the surrounding derma and of the subcutaneous tissues. By two weeks after administration of penicillin had been instituted, however, the virulent staphylococcus was insensitive to the drug, in which state it persisted until healing of the hand wounds. In spite of the insensitivity, no sign of anything more than surface contamination occurred.

Summary of Ophthalmologic Observations

A transient redness of the conjunctivae and a smarting of the eyes occurred in three of the group. These symptoms came on within a few hours after the exposure and lasted from twenty-four to seventy-two hours. In one man lacrimation was noticed, but in none was any foreign body sensation or discharge from the eyes evident during this early period. The initial symptoms cleared up spontaneously, and, although all three men had some swelling of the lids about the tenth day, two of them had no further ocular symptoms. On the fourteenth day the third man (*A*) was examined with the slit-lamp and found to have 20 to 50 tiny vacuoles in the corneal epithelium of both eyes. The eyes were entirely white, however, and caused no subjective disturbance. The patient was not examined again until severe symptoms had developed. On the forty-second day after the exposure he complained of a marked foreign body sensation in his eyes, photophobia, and lacrimation. While both eyes were affected similarly, the symptoms began, and were continuously worse, in that eye (the left) which had been nearest the source of the cathode rays during the exposure. The essential objective findings consisted of punctate and lace-like opacities in the most superficial layers of the cornea without apparent involvement of the deeper layers of the cornea or of the other parts of the eye. The whole anterior surface of the cornea was stippled by what appeared to be punctate elevations of the epithelium. With fluorescein there was extensive punctate "take" of the dye. Despite the dry appearance of the corneas, there was a superfluity of tears. The corneal sensation was not reduced in either eye.[2] The ocular signs and symptoms reached a peak within a few days after their onset and continued essentially unchanged for two weeks. They then gradually subsided, and four weeks after the onset of the acute episode the eyes were considered approximately normal, although some punctate epithelial erosions persisted in the lower portions of the cornea for several months.

The corneal changes during the acute process were interpreted as consistent with the thesis that the essential lesion was a keratinization of the epithelium with secondary punctate erosions.

DISCUSSION

The exposures to cathode rays produced burns which were analogous to but different from sunburn, thermal burns, and roentgen-ray reactions. The primary reaction was like a very intense sunburn. It lasted about the same length of time but was not followed by the usual tanning. On the contrary, there ensued a secondary reaction characterized by edema limited to the skin, with bleb formation and a sensation of a deeper burn that involved the skin at the depth of the hair follicles. The less severe reaction, particularly on the face, subsided with surprising suddenness. At the same time three of the men who had been exposed showed new areas of involvement, appearing at varying intervals, in parts which had been protected by

[2] This is in contrast to the hypesthesia that is said to be characteristic of x-ray effects on the cornea. (See review by Rohrschneider: Schädigungen des Sehorgans bei ther. Anwendung von X-ray u. Räd.-Strahlen, Zentralbl. f. d. ges. Ophth. **23**: 289, 1930.)

PLATE I

Case A

1-a. 13th day: mid-secondary phase; second-degree burn of lips and eyelids; protection afforded by the leather margin of goggles apparent on forehead.

1-b. 21st day: late secondary phase, early tertiary phase. The tissue involvement is deeper and more widespread.

1-c 28th day: tertiary phase. The protection initially afforded by the plastic material of the goggles is no longer effective; that of the leather remains effective. Epilation of eyebrows now apparent.

1-d. 42d day: tertiary phase. Healed except for the thin skin over the malar bones.

1-e. 161st day: residual atrophy, epilation, and telangiectasis of the thinner skin of the face.

2-a. 17th day: late secondary phase. The erythema persists. The deeper destruction of the tertiary phase has already begun.

2-b. 21st day: early tertiary phase. Erythema is again intensive and deeper destruction is spreading. The tertiary phase elsewhere in the body has not yet become apparent. Note absence of burn in fold between thumb and first finger.

2-c. 25th day: early tertiary phase. Erythema is less intense; deeper destruction slowly spreading. Staphylococcus albus recovered on culture. Patient on penicillin since twenty-first day.

2-d. 28th day: early tertiary phase. Second-degree destruction has reached its maximal extent but full-thickness destruction is not yet apparent.

2-e. 42d day: mid-period of tertiary phase. Maximal full-thickness skin destruction. Note gelatinous character of granulations and absence of subcutaneous edema. The contour of the knuckles is maintained and the extensor tendon of the middle finger shows through the thin layer of granulating fibrous tissue. The proliferation of epithelium is already under way. Such a picture is seldom seen following a thermal burn, where there is subcutaneous edema.

1-*a*

1-*b*

1-*c*

1-*d*

1-*e*

2-*a*

2-*b*

2-*c*

2-*d*

2-*e*

PLATE II

CASE A

2-f. 45th day: tertiary phase, early healing stage. The thin layer of slough has been dissolved by Dakin's solution. The thin layer of granulation tissue is vascular.

2-g. 54th day: tertiary phase. Wound is closing rapidly by epithelial proliferation from the periphery.

2-h. 60th day: tertiary phase, four days after grafting. Portions of the grafts are surviving, but healing is largely by peripheral proliferation.

2-i. 87th day: tertiary phase. Healing nearly complete. Note thinness of epilated skin on dorsum of both hands and all fingers of the left hand; also the separation of the nail from the nailbed of the index finger.

3-a. 28th day: initial tertiary phase, legs (1), chest (2), left arm (3). Erythema of portions of the body covered by clothing.

3-b. 33d day: middle tertiary phase. The erythema on the chest has spread and is more intense.

3-c. 42d day: tertiary phase at peak of destruction, upper legs (1), lower legs (2). The destruction extends well into the derma but is not full-thickness in any of the parts covered by clothing. Note absence of subcutaneous edema so characteristic of thermal burns. On the lower legs, note the protection afforded by the additional layer of underdrawers.

2-*f*

2-*g*

2-*h*

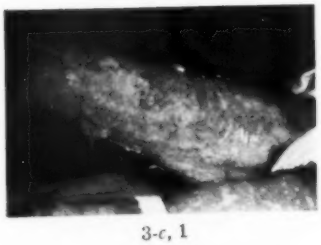
2-*i*

3-*a*, 1

3-*a*, 2

3-*a*, 3

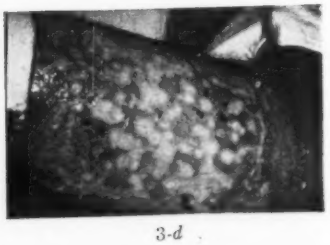
3-*b*



3-*c*, 1

3-*c*, 2

3-*c*, 3

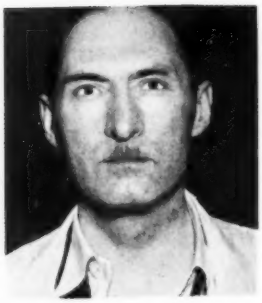


3-*d*

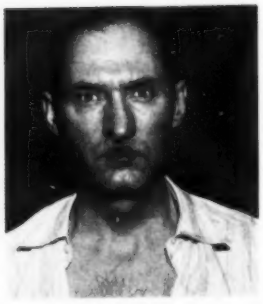
3-*e*

3-*f*, 1

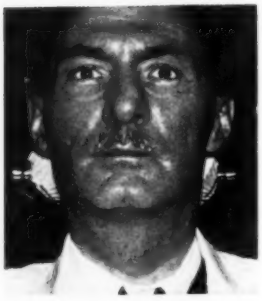
3-*f*, 2



4-*a*



4-*b*



4-*c*

4-*d*

PLATE III

Case A

3-c, 3. 42d day: tertiary phase at peak of destruction, left arm. Compare *3-a* and *3-b*, Plate II.

3-d. 45th day: tertiary phase at peak of destruction, left thigh. Epithelium is actively proliferating from islands deep in the derma.

3-e. 54th day: Late tertiary phase, left arm. All but the most deeply burned areas are healed.

3-f. 86th day: tertiary phase healed without residual pigmentation but with epilation, lower legs (1), arms (2).

Case B

4-a. 3d day: primary phase. The erythema is apparent on the forehead, face, and neck. The ears are not involved. Eyeglasses and shirt with collar gave complete protection.

4-b. 10th day: secondary phase. Erythema or first-degree reaction. The erythema is most intense in the exposed areas, but the initial protection afforded by glasses and collar is partially absent in this phase. The ears, also, are now involved.

4-c. 17th day: secondary phase at a later stage. The reaction is more intense, with initial edema. Three days later blebs appeared around the lips, followed by desquamation. Glasses and collar have given only partial protection.

4-d. 35th day: tertiary phase. Desquamation is under way and the peak of the reaction has passed. Areas of the face involved in the primary and secondary phases are now pigmented. The upper arms and shoulders, where no reaction was visible during the first and second phases, show only slight tanning. The protection afforded by multilayers of cloth is clearly seen beneath the collar and the shoulder straps of the undershirt, and the rolled-up sleeves just above the elbows. The contrast between cathode-ray burns and x-ray burns, in which no protection would have been afforded by clothing, is evident.

clothing. These areas also showed superficial edema and deep plum-colored pigmentation characteristic of the primary reaction. Some went on to bleb formation and even to destruction of the full thickness of the skin. Several areas that had healed broke down for the second time. Superficially all of these reactions looked like thermal burns, but they differed particularly in the delay in the appearance of lesions and in the fact that there was little evidence of the subcutaneous edema that is constantly seen with thermal burns.

In a thermal burn, although the necrosis may be limited to the more superficial portion of the skin, the permeability of the capillaries deep in the derma and in the subcutaneous spaces is increased and the interstitial spaces are distended with fluid. In these cathode-ray burns, this subcutaneous edema was lacking, which suggests a superficial effect and therefore absence of damage to the capillaries.

None of the lesions involved tissues deeper than the dermis. In one man permanent injury occurred in areas of maximal destruction, but the slight protection of dark adaptation glasses and clothing in certain areas prevented permanent change elsewhere. Epilation was not apparent until complete destruction of the superficial layers of the skin had occurred, and only in those areas severely injured. At the present time, six months after the exposure, the hair appears to be returning even in areas where the injury was extensive and relatively deep. Pigmentation is absent or irregular in the areas of deep burns in two men. Telangiectasis has developed in one man to a greater extent than that seen in thermal burns. Of all the queer characteristics of the cathode-ray reactions, their periodicity is the one that is unique.

In comparison with severe roentgen-ray reactions, the cathode-ray reactions became manifest much sooner and caused decidedly less pain. They did not build up to a peak but appeared to exhibit temporary lulls during which beginning healing was evident. In the men less severely burned, and even in those with extensive injury, the rate of recovery seemed to be much more rapid than would have been the case in lesions of similar extent caused by roentgen rays.

The late effects are somewhat similar, but there seems to be considerably less atrophy in those more severely burned by the cathode rays, and the tanning which usually follows roentgen-ray reaction is not seen. Pigmentation, or absence of pigmentation, is very striking in cathode-ray reactions. Pigmentation, when found, is seen as small freckle-like areas separated by non-pigmented skin; it is not so diffuse as that usually seen with roentgen-ray reactions. Telangiectases, however, seem to be common to both. Apparently the underlying tissues are not so severely damaged as in roentgen-ray reactions, since there appears to be relatively little deep fixation of the superficial layers. What the final changes may be is still unknown.

SUMMARY

1. Burns caused by scattered cathode rays in six men are described. The exact dosage could not be determined but it probably lay between 1,000 and 2,000 "tissue roentgens."

2. The lesions had the unusual characteristic of appearing in three phases, the last one becoming manifest approximately four weeks after the exposure.

3. Except for a mild injection of the conjunctiva in three men, coming on within a few hours after the exposure, no ocular signs occurred during the first two phases of reaction. Severe ocular signs developed in one man only. These appeared in the tertiary phase and consisted of punctate epithelial lesions accompanied by severe photophobia, lacrimation, and foreign body sensation.

4. The cathode-ray burns were analogous to, but different from, thermal burns and roentgen-ray reactions, in that only superficial layers of tissue were involved. This was clearly evident in both the skin and the eye lesions.

PROTOCOLS

(The story of the exposure in the following case histories is given according to each man's personal recollection.)

A. This 30-year-old resident in radiology, wearing the usual white duck uniform, is fair-skinned and wears no glasses. He had on, however, dark adaptation goggles. Being the first of the group to enter the room, before the machine was started, he moved toward it as the others followed, and probably stood closest to the tube, turned so that his left side was more exposed than the right. He estimated that for the duration of the exposures he was approximately 3 to 4 feet from the center of the beam. At one point he raised his left hand to point to the focal spot; he also pushed his goggles onto his forehead, crouched down, and looked at the focal spot from an angle of 45 to 60 degrees. Almost immediately following an approximate 30-second exposure he noticed itching, smarting, and slight burning of the eyes and lids. He experienced a similar sensation after the machine had been run again for an estimated 10 to 20 seconds. He left the room at once following the second exposure.

Approximately two hours later someone commented on the injection of the resident's eyes and on some reddening and swelling about the upper orbital areas. He had no sensation of sunburn on the face during the remainder of the day, but on arising the next morning was immediately aware of a feeling of warmth and noticed redness of the face and extreme redness of the eyes. During the following week the skin over the face, upper neck, dorsum of the hands and fingers gradually changed from a bright to a dull red, and then to a rather tanned appearance, although the tanning was not such as one usually expects following sunburn. There was associated itching of the affected areas as well as over the anterior chest and anterior thighs.

On the tenth day following exposure the face again became a dark red and was somewhat tender. At the same time the tips of the fingers in the region of the paronychia and eponychia became slightly reddened, edematous, and extremely tender. Two days later the tissue over the phalangeal joints on the dorsum of the left hand and the first three fingers of the right hand became swollen, painful, and tender. This burning discomfort was superficial and there was no associated muscle, joint, or bone pain. Shortly after this the lips began to peel and the corners of the mouth were very sore. Two weeks after the exposure the lips were markedly swollen, red, and desquamating; a raw bleeding base was apparent. The eyelids also showed second degree burn (Color Plate I, 1-*a*). It was not possible to eat or smoke with any comfort. Sleep was interrupted because of pain in the face and hands—a burning, aching, throbbing, heavy sensation. The hands were less uncomfortable when held in an elevated position. On the seventeenth day the man was admitted to the hospital for more adequate treatment of the extreme reactions of the face and hands (Color Plates I, II, III).

Progress Notes

17th Day: Face shows beginning blistering and is extraordinarily red all over the front, particularly around the nose and mouth. Both eyelids are red and inflamed, as is the forehead except where the dark goggles protected it. The hands are swollen, blistered, and very painful on motion.

20th Day: The blistering and oozing about the eyelids, nares, and mouth have grown progressively worse. The redness of the skin has increased, particularly about the eyes, where it is a deep plum color. This discoloration is far more intense and of a deeper shade than that caused by sunburn. With splinting, the hands are more comfortable.

21st Day: Face shows the late secondary and early tertiary phase of reaction. The tissue involvement is deeper and more widespread. Erythema of the hands is again intense and the deeper destruction is spreading.

22d Day: There is some recession of the redness on the forehead, but the eyelids are still cracked and oozing. Within the past 3 days evidence of burn has developed beneath the chin and about the neck up to the hairline. The redness of this newly involved area contrasts with the darker discoloration of the burns appearing earlier on the face.

27th Day: Face is worse. The lower eyelids are badly blistered and oozing; some blistering on the forehead and face, although the erythema is beginning to fade on the sides of the face. The erythema on the neck below the hairline has extended down over the front of the chest, arms, forearms, thighs, and legs, all on the left anterolateral aspect.

28th Day: Involvement of areas on face initially protected by goggles now evident. There is epilation of the eyebrows. Second-degree destruction appears to have reached its maximal extent in the hands.

32d Day: Face is much better. It now shows several small areas of real though superficial ulceration over the front of the cheeks; the remainder of the reaction is rapidly subsiding. The lower neck is peeling, the redness has quieted down. A new lesion has appeared on the toes of the left foot. This is now red, as is the entire front of the chest, where the erythema has spread and become more intense. The abdomen also is red, and sweats and itches. The patient feels well, but is still in the hospital.

45th Day: Face is almost clear; the redness, oozing, and blisters are gone. The arms and legs are more comfortable but still require bandaging. The hands are improving. The maximal full-thickness skin destruction was reached several days ago. Proliferation of epithelium is already under way. The granulations are gelatinous in character, and subcutaneous edema is absent. The contour of the knuckles is maintained and the extensor tendon of

the middle finger shows through a thin layer of granulating fibrous tissue. In this respect these burns differ from a thermal burn, in which the subcutaneous tissue would also be involved. The left hand is more severely injured than the right.

56th Day: The face, which suddenly began to improve a week ago, is practically free of redness and subjectively is comfortable. The skin is smooth and more normal looking. On the left shoulder is a scaling, healing second-degree burn about 1 inch in diameter. Some crusting areas remain on the left forearm and elbow. The right shoulder is also crusted. The lower legs show a little thickening of the skin, with crusting in several small areas. All the eyelashes on the left and the lower lashes on the right have come out. The right hand shows a long area over the thumb which is rapidly epithelializing. The left hand was grafted today.

80th Day: Has been back at work a week and is feeling well. A few small thin scars remain on the face. The skin around the eyes is extremely thin. The lashes, which had fallen out from both lids of both eyes, are beginning to grow on the upper lids. The hair on the exposed part of the wrists is still entirely gone. The right hand shows a few small crusts over the dorsum and the skin is thin. The thumbnail is almost off. On the left hand the index finger and thumb are losing their nails; a new one is growing on the finger.

87th Day: Healing of the hands is almost complete. The epilated skin on the dorsum of each hand and all the fingers of the left is thin, and the nail of the left index finger is necrotic.

96th Day: Is in excellent condition but looks older. The skin of the face is more wrinkled than formerly and has a mottled appearance. The eyebrows and upper eyelashes are growing but still look somewhat moth-eaten. The greatest loss of eyebrows occurred in the unprotected area adjacent to the leather edging of the goggles. (The question has been raised as to whether secondary rays were given off from the leather in this localized area.) Hairs, which had been heavy over the bridge of the nose, have disappeared entirely. The skin has a practically normal pink color except for mottling, and the usual pigmentation which has been lost in other burned areas is still in evidence on the forehead, which was covered by the dark glasses.

173d Day: Condition is about the same as it was three months ago. There are no lashes on the lower eyelids. The hair is beginning to regrow on the epilated areas of the extremities—over the deeper burns on the hands, and over the arms and legs. A band of heavy hair which was protected by the strap of a wrist-watch stands out in marked contrast to the epilation of the rest of the hand and forearm. The beard is intact. The skin, except for the protected area on the forehead, shows a striking loss of yellow pigment; it is pink in contrast to the more yellow unburned areas. There are, however, a good many areas with freckling which are of deeper color than the normal skin that shows no freckling. There are a few telangiectases. In the more severely burned areas there is scarring with some fibrosis but there are no contractures. Though the skin of the left hand is rather tight, treatment has prevented any loss of motion.

Addendum Oct. 1, 1945. 304th Day: Since the last note there have been further changes. The telangiectases of the face have become somewhat more prominent, and the skin over the dorsum of the left hand and dorsum of left index and middle fingers by the 190th day had thinned out, with beginning necrosis. At first the skin changes in the hand were treated conservatively, but a 4-mm. area broke down and began to granulate. Since the tendon to the index finger was immediately beneath the open wound, secondary plastic procedures were decided upon. The affected skin was excised and a flap graft from the abdomen was placed over the tendon. The remainder of the wound was closed with a split-thickness graft. At operation it was noted that the vessels beneath the area of reaction were not thrombosed, as is usually seen in x-ray reaction. There was no evidence of necrosis or fibrosis beneath the skin. The earlier impression of the superficiality of the effect of the cathode rays was confirmed.

The grafts have taken successfully. Today, ten months after the accident (93 days after grafting), the hand is healed, and the general condition is the same as on the 173d day.

Ophthalmologic Progress Notes

(During the exposure, *A*, who wore no eyeglasses, stood so that his left side was nearer the source of the cathode rays. Within an hour he was aware of smarting of the skin of the face and of the eyes, likened to a sunburn sensation but unaccompanied by any foreign body sensation. Mild redness of the eyelids and conjunctivae was noticed within two hours after the exposure.)

1st Day: Mild conjunctival redness. On slit-lamp examination the corneas show no abnormality; lids show no abnormal folliculosis.

2d Day: Conjunctival redness has disappeared.

12th Day: Swelling of lids (and peri-oral region). Eyes white; corneas clear.

14th Day: Swelling of lids worse and accompanied by ulceration of skin surface. Conjunctivae are white. On slit-lamp examination the corneas show 20 to 50 tiny vacuoles within the epithelium, and the precorneal tear film contains somewhat more debris than normal. The patient has no symptoms referable to the eyes.

42d Day: Foreign body sensation noted for the first time, in the left eye only.

43d Day: Foreign body sensation, epiphora, photophobia, and considerable discomfort, but still in the left eye only. Gross examination shows ciliary injection and a nebulous superficial opacity in upper thirds of both corneas, more on the left,

accompanied by a stippled and dry appearance of the corresponding surface. The remaining portions of the corneas are normal, and the affected portions are demarcated from the unaffected portions by a horizontal line corresponding to the upper lid margin. The stippled areas show punctate staining with fluorescein. There are no marginal infiltrates. *Smears* of the conjunctival secretion show no eosinophils, inclusion bodies, or bacteria. *Cultures* taken from both eyes show coagulase-positive *Staphylococcus aureus* and attenuated hemolytic streptococcus. The patient was given penicillin ung. t.i.d. locally.

46th Day: Severe photophobia, foreign body sensation, and epiphora in both eyes. The eyelashes have fallen out completely from lower lids of both eyes and upper lid of left eye. Right eye shows marked ciliary injection. The surface of the upper half of the cornea has a dry appearance, with the stippling previously noted. No grossly visible opacity in this area. In the lower portions of the cornea there is a faint but definite opacity extending onto the lower cornea approximately 1 mm. from the limbus between 4 and 8 o'clock. The rest of the cornea has an irregular surface causing optical distortions but no opacity. Slit-lamp examination proved somewhat unsatisfactory because of extreme photophobia, but a faint haze of the epithelium can be made out in the central regions of the cornea; in the upper or more severely affected portions there appear to be punctate elevations of the surface. With the fluorescein stain there is no "take." The corneal sensation is normal. There is no edema of the corneal epithelium, and the corneal stroma is entirely clear; the posterior surface of the cornea shows no folds, and the anterior chamber shows no cells nor outstanding beam. The pupil is normal in size and reaction. *Left eye* shows the same signs as does the other eye, with a definite nebulous and trellis-like opacity in upper half of cornea and punctate "take" with fluorescein stain in lower half of cornea. The corneal sensation is normal.

49th Day: Examination essentially the same as previously noted except that each eye shows a generalized haze made up of punctate white flecks over the entire corneal surface; these flecks take the fluorescein stain. Pencillin ung. discontinued, and patient given 5 per cent sodium chloride ung. and 1 per cent atropine sulfate ung.

53d Day: Considerable subjective improvement. *Right eye* shows less ciliary injection and less pronounced stippling of cornea; numerous punctate flecks over entire corneal surface, which take the fluorescein stain. In the *left* eye, ciliary injection is unchanged; anterior surface of cornea shows a diffuse nebulous opacification with much punctate staining by fluorescein. With the slit-lamp this opacification appears to be confined to the epithelium and to be made up of granular white spots and ill-defined lines. There is no epithelial edema. The corneal stroma is entirely clear, and the posterior surface shows no folds. The corneal sensation of both eyes is normal. Tearing measured by the Sjögren method is 10 mm./2 min. for both eyes.

57th Day: Examination shows marked improvement. *Right eye* is practically white. Corneal surface is smooth and lustrous. There is no stippling, but there is some irregularity of the surface on the left side of the cornea. *Left eye* shows mild ciliary injection. Stippling of corneal surface is still present but less marked. In the lower temporal quadrant of the left side, where the stippling was most evident, there is a superficial opacity measuring approximately 1.0 × 0.5 mm., extending upward from 6 o'clock. This opacity appears to be limited entirely to the epithelium. The rest of the cornea is normal.

60th Day: Further subjective improvement. In the *right eye* the only abnormality is some punctate areas that take the fluorescein stain. These are situated in the lower half of the cornea. *Left eye* shows continued mild ciliary injection. The cornea is lustrous except for the area previously described in the lower temporal quadrant. Here there is an elevated opacity, and from it there now appear to be thread-like lines in the epithelium, running transversely to lower nasal quadrant. There are considerable punctate staining of the entire surface with fluorescein and a mottled appearance to the specular reflex.

63d Day: *Right eye* entirely normal. No "take" with fluorescein. Corneal sensation normal. Lens clear. *Left eye* shows mild ciliary injection. Moderate punctate staining with fluorescein in lower third of cornea. In lower temporal quadrant there is the elevated gray area, now triangular in shape, measuring approximately 0.5 mm. on each side. This area does not, however, take the fluorescein stain. The corneal sensation is not diminished. The lens is clear.

69th Day: *Both eyes* white. The only abnormal residuum is the small elevated opacity in the lower temporal quadrant of the *left eye*.

76th Day: *Both eyes* entirely negative except for the absence of lashes of lower lids.

127th Day: The only ocular complaint is a slight purulent discharge in the morning. Examination of *both eyes* shows complete absence of lashes of lower lids, although the hair follicles can be easily made out; the posterior margins of the lids are unusually prominent, having a translucent lip rising approximately 0.5 mm. above the rest of the lid margin and with scalloped edges. The lower portions of the corneas show a few punctate gray flecks extending upward from the limbus 1–2 mm. between 4 and 8 o'clock. These flecks take the fluorescein stain. The rest of the corneas are normal.

189th Day: Eyes appear white and patient has no complaint other than slight discharge in the morning. Examination shows the same findings as previously noted except for some reduction in the number of punctate gray flecks on the surface of the

lower portions of the cornea. These corneal changes can be seen only with the slit-lamp. On gross examination the eyes would be considered normal. Vision is normal.

Addendum Oct. 1, 1945. 304th Day: Patient's only ocular complaint continues to be slight discharge in the morning. There is still practically complete absence of lashes of lower lids, but hair follicles are present; upper lids show only slight reduction in lashes. A noteworthy change from the status at the previous examination is the dilatation of the vessels on the conjunctival surface of both lower lids. This is especially conspicuous on the left side, where the vessels form gross telangiectases and in one area extend over onto the anterior surface of the lid. The bulbar conjunctiva and cornea of each eye appear normal in every way.

B. On the morning of the day the accident occurred, this 40-year-old physicist, with medium-fair complexion and wearing eyeglasses, had entered the room twice while working on the machine. He was wearing no coat and his shirt sleeves were rolled above the elbow during the time he was exposed. Inasmuch as there is no magnetic focusing device on the machine, it was necessary either to burn holes in film or, to determine where the focal spot was located on the target in a quicker manner, to look at it through a mirror. Being uncertain in which direction the focal spot was wandering, the physicist took a brief look directly at the window, noting that the focal spot was considerably to the side of the target. After adjusting the machine, he again entered the room to observe the fluorescent target, receiving a second exposure. He estimated that during each exposure he stood not closer than 4 or 5 feet to the center of the beam and was not in the room longer than 10 seconds. He observed nothing unusual physically but smelled a slight odor which he thought to be due to ozone in the room. He did not enter the room in the afternoon, when the other five men were exposed.

He noticed no abnormal sensations until the next morning, when shaving, he was *aware* of his skin without feeling any true pain. Two hours later, when he reached the hospital, it was apparent that his face and the exposed surfaces of both arms and forearms were reddened. There was questionable slight injection of the conjunctival vessels but no abnormal sensation. By the end of the day some redness was noticeable over the shoulders and that portion of the chest which had not been protected by his undershirt. This regressed fairly rapidly and did not cause any subjective symptoms. Four days after the exposure slight irritation of the eyes appeared about the outer canthi; this cleared up in five days. During this period the color of the skin faded, but not constantly, since the redness recurred intermittently (Color Plate III, 4-*a* to *d*).

On the eighth day after the exposure the areas about the nose and upper lip became sore and edematous, and "cold sores" appeared at the corners of the mouth. On the tenth day, the nose was red and swollen, as was the anterior portion of the chin. Shaving over this latter area was painful, although the sides of the face remained nearly normal. The lips became sore, cracked, and blistered. The reaction continued acute until the fourteenth day, when there was a sudden decrease in the amount of pain and edema. The face continued to improve. On the eleventh day, the backs of the hands became red and tender.

Progress Notes

13th Day: The face shows a sharply demarcated area of redness beginning below the glasses and extending sideways to the mid-cheeks and downward to the edge of the chin. The man is bald over the front of the head but this area was not involved. He wears a short mustache, which is not affected; his upper lip is sensitive but less so than a week ago. The lips are healing but slight cracks are still present. The mucous membrane inside the mouth is normal; the tongue is normal. The nose and lower jaw appear a little bumpy, uneven in texture. The backs of the hands show increasing erythema.

17th Day: The face shows marked improvement. Both hands show great redness but no blistering, with sharply delineated lines where the skin was protected from superficial exposure, as between the fingers. Chlorophyll ointment has been used on the left hand, covered with a white cotton glove. The area on the left fourth finger protected by a wedding ring shows no redness nor edema. There is superficial desquamation over the dorsum of the right hand with good dermis beneath it. This hand is put up in splint and bandage today.

27th Day: As the lesions on the hands were clearing, erythema developed on areas not previously involved, on the shoulders and on the upper and anterior portions of the chest.

32d Day: Face looks entirely normal; hands are slightly red but otherwise normal.

45th Day: Entirely recovered. Face remains normal. The skin on the hands is slightly redder and softer than usual but is otherwise normal. The skin over the slightly involved areas on the shoulders is peeling.

182d Day: As far as can be determined, except for questionable atrophy of the skin over the backs of the hands, there are no late effects. Where epilation occurred, hair is growing.

Addendum Oct. 1, 1945. 304th Day: There have been no particular changes in general condition. It was noted through the summer that no tanning followed exposure to sunlight over the dorsum of the right hand and forearm.

C. This 37-year-old resident in radiology, wearing the usual white uniform, is dark-skinned and wears eyeglasses. He was in the room about 5 minutes and during the exposure stood about 6 feet from the target, bending down at one point for 5 to

6 seconds. His face became very red, shiny, and edematous almost at once. Later in the day he noticed some burning and stinging of the face, particularly about the eyes, and by evening it felt hot. On the second day his eyes were inflamed and burning. They cleared rapidly, returning to normal by the fourth or fifth day. The acute redness of the face faded after about four days. At this time diffuse redness appeared over the chest; it had disappeared twelve days after the exposure. As the superficial redness left his face, a deeper reaction developed and progressed. This was characterized by marked tenderness, so that shaving was painful. The lips became cracked at the edges and showed a line of herpes, ulcerating where the dry and the moist edges joined.

Progress Notes

13th Day: The most marked lesion is about the mouth, where the patient shaves. The edges of the lips are cracked, and opening the mouth causes pain. The lower lip is denuded all along its edge; both lips are swollen and hot. Hands show increasing erythema on the backs.

17th Day: Face still shows areas which ooze. The hands show dorsal desquamation, redness, and edema. After being dressed with chlorophyll ointment they were bandaged and were definitely more comfortable when immobilized.

19th Day: Face improving; redness around peri-oral area remains. Hands are kept bandaged. A little clear fluid oozes from the left hand.

27th Day: Face practically normal. Right hand out of bandage; new skin covers the desquamated area.

30th Day: A new area of erythema has appeared at the root of the neck.

32d Day: Face looks normal. The skin has peeled from the hands, leaving a slightly red new dermis. The recently involved area on the neck is now sharply delineated, dark red in color. Areas of erythema have appeared also over both knees.

33d Day: Skin over both knees is red, painful, and tender to touch.

45th Day: A circular area about 7.5 cm. in diameter is present over each knee. After the appearance of these lesions 2 weeks ago, they became progressively worse subjectively and objectively. They are now subsiding but still show swelling, discoloration, and scaling. They are no longer tender.

57th Day: Seems perfectly well. Skin has regained its normal color. Although no epilation occurred on the face, it was evident in other areas and is still apparent on the dorsum of each hand, over an area on the right forearm and a small area on each knee.

182d Day: The skin over the backs of the hands is soft, and hair is growing in the areas of most severe injury. In this same area a very faint freckle-like pigmentation is noticeable. Otherwise there are no visible late effects.

Addendum, Oct. 1, 1945. 304th Day: There has been no change in the general condition, except that there has been no tanning on exposure to sunlight over the right first and second and the left first, second, and third knuckles.

D. This 24-year-old blond medical student, with eyeglasses, was wearing an Army uniform but no blouse. The total time he spent in the room did not exceed 8 minutes, and during most of it he stood 5 or 6 feet away from the direct beam. At one time, for about 30 seconds, he bent down so that his head was about 4 feet above the floor and 3 feet from the direct beam, in order to observe more closely the "hot aluminum plate" and a piece of fluorescent material on the floor directly beneath the tube.

He experienced no ill effects from the exposure until the following evening. After running several miles for exercise, he then observed some reddening of the cheeks, which he attributed to wind burn. Twelve hours later, this initial change instead of subsiding had expanded into a slight but definite diffuse "blush" over the entire face anteriorly, avoiding, however, the sides of the cheeks, temples, and ears. A subjective feeling of warmth over the same area, without tenderness, accompanied the reddening.

In the next 4 days, as the color became more intense, the regions of most extensive injury were seen to be those around the bridge of the nose and lateral to the nares and around the lips. For a time these areas, unlike sunburn, had a "blotchy" appearance. The skin increased in warmth and became sensitive. On the eighth day after exposure, the lips were swollen slightly, dry, roughened, and inclined to chap readily. The tendency to fissures was controlled for 3 days by a proprietary "chapstick."

About 4 days after exposure, a slight but indisputable erythema appeared over the anterior portions of the shins, thighs, upper chest, and arms. The hands and areas covered by collar and shorts were normal in appearance. The patient's eyeglasses with plastic frames seemed to have afforded complete protection.

The warmth, swelling, and redness, particularly about the mouth, slowly increased. On the tenth day, a slight superficial desquamation and tendency to fissure formation when the skin was wrinkled was observed over an area on the nose 1.25 cm. in diameter. This cleared up in 3 or 4 days. On the eleventh day, a similar area appeared between the lower lip and chin, underwent identical changes, and healed in about 12 hours, only to be followed by the development of more severe cracks and crust formation at the corners of the mouth. These healed in about a week.

The entire reaction probably attained its maximum in disfigurement and discomfort on the sixteenth day following exposure. The lips were sore, swollen, and burning, especially at the mucocutaneous junction. The mouth could not be opened widely;

citrus fruits, acid- or vinegar-containing food could not be taken without sharp pain. Exposure to cold (15° F.) for several hours seemed to aggravate the tenderness and erythema. Alcohol produced a transient, but considerable increase in color. Smiling, laughing, or even talking with expression was most uncomfortable from the fourteenth to the eighteenth day after exposure. Bland ointments afforded relief. At no time was the pain sufficient to interfere with sleep or pleasure.

On the eighteenth day after exposure, subsidence of the lip swelling was beginning. The skin of the forehead, nose, and chin still felt somewhat stiff and inelastic, was slightly thickened, burned when stretched, and itched at times. The color had darkened from its fiery redness, and those areas more lightly involved showed a slight tan. The most seriously affected areas resembled a fresh sunburn; they were still warm to touch, blanching on pressure. They were no longer tender or painful.

The patient had no tertiary reaction and appeared and felt perfectly normal 2 months after the accident. At the time of writing, 6 months after it, no late effects are apparent.

Addendum Oct. 1, 1945. 304th Day: No further changes noted. No peculiarities regarding exposure to sunlight throughout the summer recognized.

E. This 33-year-old physician, having fair skin and wearing no eyeglasses, estimated that he was in the room about 2 minutes, standing 4 to 5 feet away from the direct beam. He glanced at the fluorescent window and almost immediately noticed irritation of his eyes, which at the time he attributed to ozone and the film which had been burned in the room. He was standing in the doorway of the room when the second exposure was made.

Within 5 minutes the conjunctival vessels of both eyes were seen to be markedly injected. An hour later the face was red and felt warm. Within 4 hours there was a rather marked erythema of the face and of the right upper extremity from the tips of the fingers to the shoulder, except for an area covered by a rolled shirt sleeve. The physician had been wearing a white coat at the time of the exposure and the anterior chest which was not protected by the coat showed some erythema. The peak of the reaction in the conjunctivae was reached in 20 hours and subsided thereafter. From the fifth to the tenth day the erythema gradually decreased to an atypical tan. No additional areas of redness appeared, although there was some tingling felt along the anterior and lateral margins of the right lower leg. The only sensations noted other than this were the feeling of warmth of the skin and some itching. The reddened areas were treated with lanolin.

On the ninth day, after the physician had been doing some painting at home, his face became extremely uncomfortable; over the anterior portion it appeared a livid red, and definite edema was noticed. It grew worse during the next 3 days, becoming very tender—particularly painful on shaving—with marked swelling of the eyelids.

Progress Notes

13th Day: Superficial skin can be rubbed off the lower jaw. Herpes-like lesions which had appeared along the upper lip, at the junction of the mucous membrane, are now healed. The entire face is still red and slightly blotchy, more especially the lower face. The eyelids are still edematous, but improving. The chest is slightly red. The arm is normal; the demarcating line which indicated the end of the rolled-up sleeve is no longer visible. Last night the deep tenderness suddenly ameliorated as the edema decreased.

17th Day: Approaching normal.

20th Day: Face appears entirely normal.

182d Day: Has remained normal. No unusual effects have followed exposure to cold or to sunlight. No epilation was noted at any time.

Addendum Oct. 1, 1945. 304th Day: No further changes noted. No peculiarities regarding exposure to sunlight throughout the summer recognized.

F. A 22-year-old medical student, with dark olive complexion and wearing glasses, estimated that he was in the room for 10 minutes. He believes that he stood about 8 feet from the target most of the time and was in an upright position except for a brief look at the fluorescent window. He was wearing his Army uniform without the blouse. He experienced no immediate reaction of any sort.

On the ninth day after the exposure he thought there was some questionable erythema on one leg, but it had entirely disappeared by night. On the eleventh day, after shaving, he noticed that his face was very sore and quite red generally. During that day the face felt as if it were chapped, with a sensation of dryness and stiffness, and it was difficult to open the mouth widely. There were swelling and scaling of the lips, with a somewhat herpes-like lesion present.

All tenderness and pain subsided abruptly on the thirteenth day. The upper peri-oral redness and edema continued to subside up to the eighteenth day, when the appearance was normal. There were no subsequent ill effects.

Addendum Oct. 1, 1945. 304th Day: No further changes noted. No peculiarities regarding exposure to sunlight throughout the summer recognized.

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Roentgenology of the Draining Bronchi from Tuberculous Cavities[1]

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THE ROENTGEN appearance of the lung in the area between a tuberculous cavity, or the site of a previous cavity, and the hilum is of special importance. This portion of the lung contains the regional bronchi and peribronchial vascular and lymphatic channels which drain the area of the parenchymal lesion toward the lung root. These draining bronchi are frequently involved by the tuberculous process. In fact, many experienced investigators think that they are almost invariably involved. Heretofore the diagnosis of tuberculous bronchitis has depended solely upon bronchoscopic findings, or upon circumstantial clinical evidence, or indirect roentgen signs. It is believed, however, that the roentgen appearance of the diseased bronchi may be sufficiently characteristic to permit some opinion as to their status.

Although the present report is based upon independent investigation, several authors have previously given excellent accounts of similar roentgenographic studies. In spite of the paucity of such reports, they are so accurate, and in such agreement with the everyday practice of roentgenology in a tuberculosis hospital, that it is surprising that the roentgen appearance of the draining bronchi from tuberculous cavities seems to be so little known. Ameuille and Levesque (1), in 1923, referred to the *bronche de drainage*, and gave a clear description of the roentgen findings. They described the diseased bronchus as being visible between the cavity and the hilum. It is seen as two usually parallel lines of opacity, the walls of the bronchus, between which lies the radiolucent bronchial lumen. Wolf (11) confirmed these findings with Ameuille and published excellent roentgenograms to demonstrate them. Ameuille, Delhomme, and Raust (2) subsequently made pathological studies of these draining bronchi. Raabe (8) also described the same findings.

Recently there has been a noticeable increase in the clinician's interest in these bronchi (5, 9). It is now better known that the course of the cavity is inextricably bound to the status of its draining bronchus. As to the latter, however, most of the opinions expressed have been based on clinical evidence, bronchoscopic findings, or circumstantial roentgen signs, such as the presence of "balloon" or "tennis ball" cavities, or peripheral atelectasis, or obstructive emphysema. Selective collapse and anomalous behavior of cavities under pneumothorax have all been linked to the bronchial state. Recent references to the direct roentgen signs of tuberculous disease have been sparse. Coryllos (3) emphasized the physiologic importance of such bronchi and described the occasional well known resemblance of the pathological shadow to a tennis racket, the draining bronchus representing the handle. He termed such cavities "stem cavities." Holcomb and Weber (4), likewise, in referring to the shadows which appear between the cavity and hilum, state that the stem of the stem cavity probably represents the draining bronchus filled with fibrotic tissue. Peirce and Curtzwiler (7), in a more recent valuable contribution, discuss the direct and indirect roentgen signs of tuberculous tracheobronchitis. Oechsli (6), without knowledge of the previous reports, described the bronchial shadows. He gives an accurate and clear description which coincides with the findings of the previous investigators and with our own independent interpretation.

[1] From the service of Dr. A. L. Bachman (now with the Armed Forces), Dr. I. Startz, Director of Roentgenology, Triboro Hospital for Tuberculosis, Jamaica, N. Y., Department of Hospitals, New York City. Accepted for publication in January 1945.

Fig. 1. Incipient disease of the draining bronchus from a tuberculous cavity. This cleared rapidly after the cavity healed. Edema or slight inflammation of the mucosa, either non-specific or early specific, makes the bronchus visible on the film.

Fig. 2. Early disease of the draining bronchus from a tuberculous cavity. The thickened bronchial wall is seen as two dense, closely related parallel lines separated by a central shadow produced by the bronchial lumen. (Figs. 1 and 2 are contact prints.)

The mode of involvement of the bronchi is not exactly known. Their regional distribution in the drainage areas of the cavities speaks for a direct implantation of the tubercle bacilli from the infected secretions that drain through them. Less commonly the bronchi may be involved by direct spread through the wall from a contiguous pulmonary lesion or lymph node. Some authors believe that the walls of the bronchi are involved *via* the peribronchial lymphatics which drain the primary site. Submucous extension is common. The simplest explanation, and one which fits in with the roentgen appearance, is that the bronchi are involved by direct extension from the cavities they drain and by direct implantation from the infected material that is drained through them.

The roentgen appearance of the draining bronchi will vary with the severity and duration of the underlying disease process. The bronchial disease may persist after the drained active parenchymal process has subsided. Early, an edema or slight inflammation of the mucosa or other parts of the bronchial wall may be reflected in a

Fig. 3. Tomographic section of a bronchus draining a cavity just over the dome of the right diaphragm. Early disease is shown. Note that the dependent portion of the bronchial wall, over which the main burden of the infected secretions drains, is thicker than the superior portion. The identity of the draining bronchus is well shown. (Contact print.)

simple increased visibility of the bronchial shadow. It is possible that this stage is non-specific and is merely an exudative response, either inflammatory or allergic, to the infected material bathing the mucosa (Fig. 1).[2] In any case, the rapid clearing of such a prominent bronchial shadow suggests either a non-specific process or a very minimal tuberculosis. At this stage there may be complete reversibility of the lung shadows to normal or the resolution may be so great as to leave no detectable residual roentgen markings.

When the bronchial disease has progressed just beyond the non-specific or incipient stage, it is associated with submucous tubercles and, later, with submucous extension and infiltration. The lesion may extend to the surface of the lumen, causing an elevation of the mucosa, or it may permeate into other parts of the bronchial wall, with resultant bronchial thickening. At this stage the roentgen visibility of the bronchial shadows is further increased. The walls of the bronchi are seen as two closely related, dense, parallel lines, separated by a central shadow caused by the lumen. This can frequently be recognized even when disease in the contiguous parenchyma tends to obscure the shadows (Fig. 2). We have been impressed with the value of tomography in verifying the impression of bronchial disease. It is the opinion of the majority of pathologists that the dependent portion of the trachea, over which most of the infected material passes, is the site of greatest involvement (10). Tomography of a draining bronchus with a thickened dependent wall (Fig. 3) would seem to indicate that the same is true for bronchi.

When the infection extends through the mucosa, ulceration results. Further growth above the surface causes irregular granulomatous lesions (10). These ulcero-

Fig. 4. Established disease of the draining bronchus from a tuberculous cavity. The irregular bronchus may be seen extending from the hilum toward the base of the cavity. The shadow between the cavity and the hilum is due to the bronchial disease and peribronchial reaction.

[2] The photographic work for this paper was done by the chief staff photographer, Suzelle Brinkley. Contact prints have been used for Figures 1–3, as these show the early lesions to better advantage.

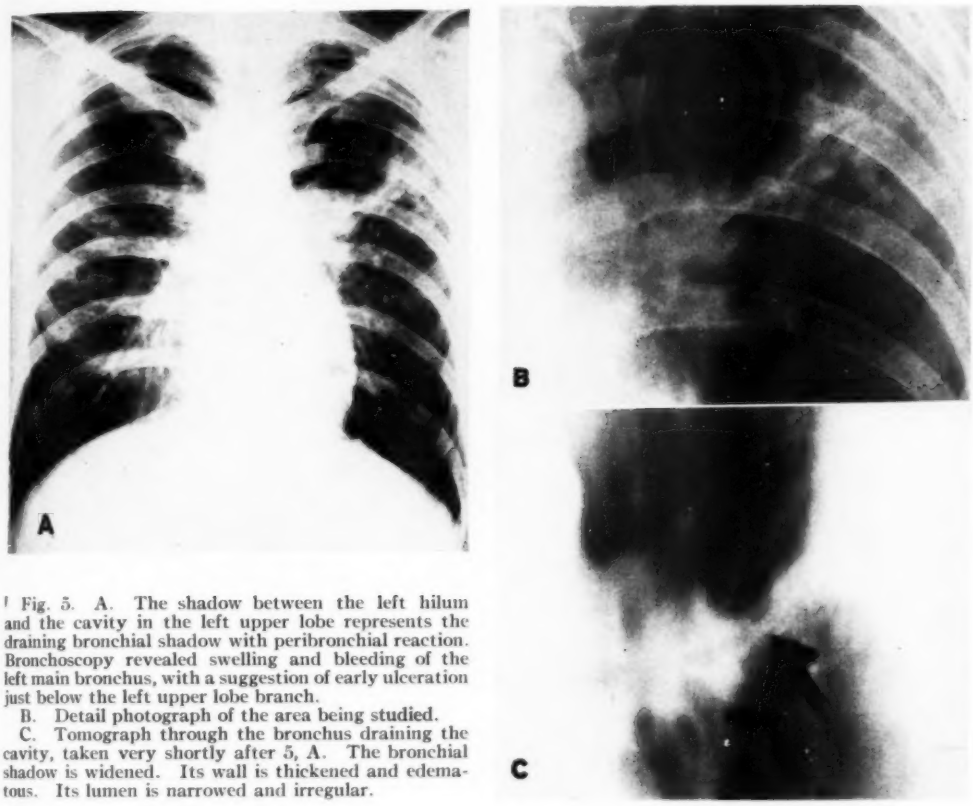

Fig. 5. A. The shadow between the left hilum and the cavity in the left upper lobe represents the draining bronchial shadow with peribronchial reaction. Bronchoscopy revealed swelling and bleeding of the left main bronchus, with a suggestion of early ulceration just below the left upper lobe branch.

B. Detail photograph of the area being studied.

C. Tomograph through the bronchus draining the cavity, taken very shortly after 5, A. The bronchial shadow is widened. Its wall is thickened and edematous. Its lumen is narrowed and irregular.

granulomas represent a very active stage of the disease, during which there is continued extension along the bronchial wall (5). It is to be expected that all layers of the bronchus will now be affected. The bronchial wall shadow will be denser, more irregular, and wider in diameter. Its lumen will be narrowed and irregular. A peribronchial reaction will be present in the contiguous pulmonary areas. This may occasionally be seen as a soft exudative shadow which lies between the cavity and the hilum (Fig. 4). While in most instances the bronchial shadows will be identifiable, nevertheless, even in the absence of exact identification, the shadow between the cavity and the hilum must be attributed to the regional bronchial and peribronchial pathology. While the bronchoscopist may now be limited to the visualization of one end of the lumen of such a lesion, the radiologist may demonstrate it in its entirety.

If the ulcerogranuloma completely fills the bronchus, the occlusion may cause peripheral atelectasis. Myerson (5) believes that when a suppurative focus drains *via* the bronchus, the washings tend to prevent complete occlusion. With continued advance of the disease, the surface of the ulcerogranulomatous lesions may degenerate. Myerson calls this stage "ulcerogranuloma with caseation," and states that it has also been called caseous endobronchitis (Loeschke) and caseous necrotic bronchitis (Ornstein and Epstein). It is expected that the bronchial and peribronchial shadows at this stage will be even more pronounced (Fig. 5). Several bronchi may drain a larger area of involvement, as may be demonstrated on the roentgenogram (Figs. 8, 9, 10). Resolu-

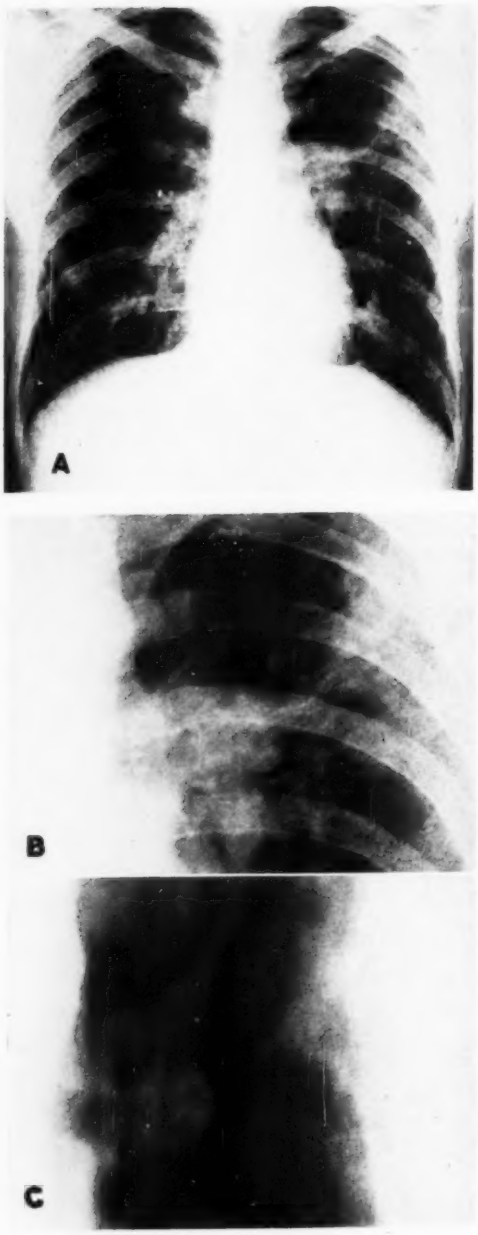

Fig. 6. Same case as Figure 5, approximately seven weeks later, showing some resolution.

A. The cavity is no longer seen. The shadow between the hilum and the primary lesion has begun to resolve.

B. Detail photograph of the area being studied.

C. Tomographic study of the bronchus, showing it to be still diseased. Its walls, although still involved, are thinner than on the first study. The bronchial lumen is wider and less irregular. (This film was difficult to reproduce successfully.)

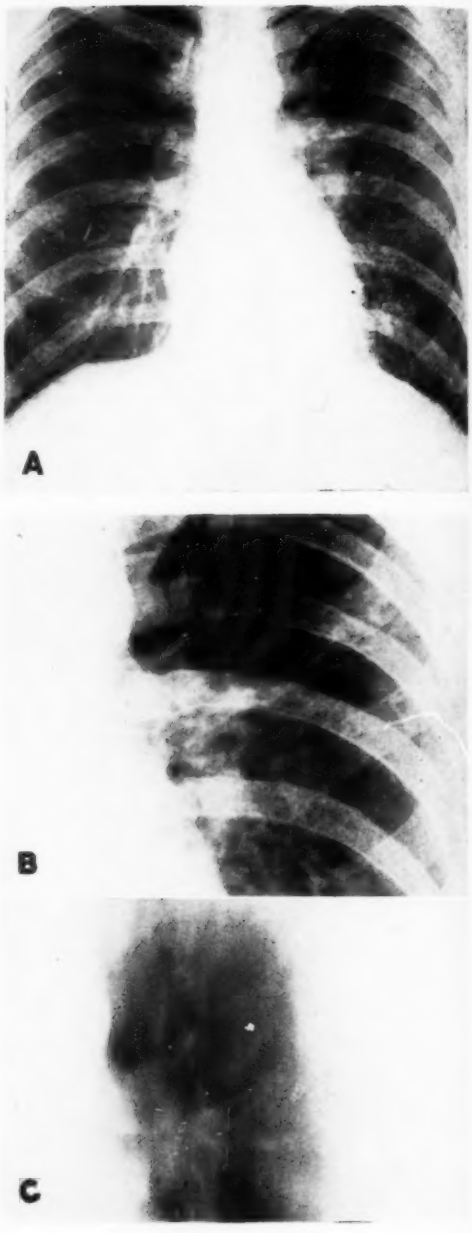

Fig. 7. Same case as Figures 5 and 6, approximately seven months later.

A and B. The site of the original cavity is indicated by a few hardly distinguishable markings. The bronchial shadows are still visible, but much less marked than before.

C. Tomograph showing the bronchus to be thin-walled, and its lumen more regular and patent. There is a slight residual thickening of the walls; otherwise there has been a remarkable resolution of the tuberculous process as compared to the original status. Compare this with Figure 5, C, taken through the same level.

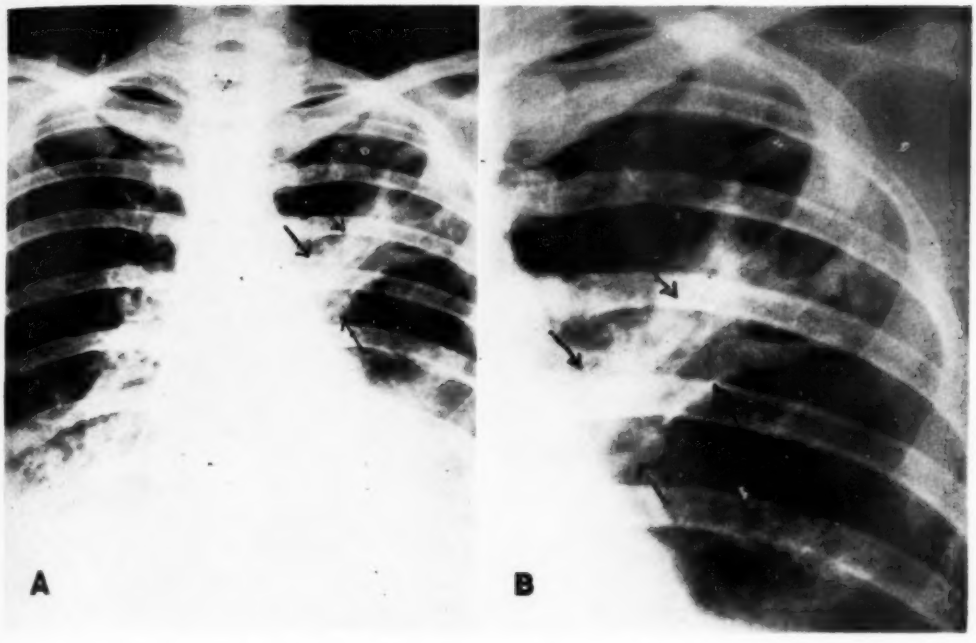

Fig. 8. A. Draining bronchi from multiple tuberculous cavities in the left upper lobe lie between the cavities and the hilum. B. Detail photograph of the area.

tion of the tuberculous bronchitis, with healing of the cavity being drained, is almost invariably associated with some fibrous changes. The clearing of the extensive disease is reflected by a reversal of the roentgen findings, with diminished visibility of the bronchial shadow and a return of its wall thickness and lumen outline toward normal (Figs. 5, 6, 7). When the disease has been extensive, however, the fibrous residua may be represented as well demarcated linear fibrotic strands which extend outward from the hilum into the lung fields (Fig. 7). These are frequently misinterpreted as being due to previous parenchymal rather than bronchial disease.

If the cavitation or pulmonary suppurative disease becomes worse, the draining bronchi will reflect this by advance of the chronic changes in their walls. The productive changes in the wall produce a rigidity, straightening, and shortening. The condition is associated with varying degrees of stenosis, caused by scarring and fibrous changes. The partial or complete occlusion of the bronchial lumen may contribute to bronchiectatic changes in the peripheral arborization, especially since the walls are already diseased. Stiffening of the bronchial walls may keep them rigidly patent, as with arteriosclerotic arteries (Coryllos) (Fig 10). Occlusion of the bronchus, rigid patency of the bronchus, or ball-valve mechanisms would be reflected in the status of the cavity or the peripheral lung.

The presence of linear bronchial markings which extend into the lung field from a hilum should lead to the suspicion that a hidden cavity is being drained. In the presence of such shadows, a careful search, including tomographic study, should be made before the presence of a cavity is excluded (Fig. 11). As a corollary to this, in the presence of a radiolucent area of doubtful nature, the finding of a draining bronchus might indicate that the radiolucency was due to a cavity.

This article has been restricted to a pres-

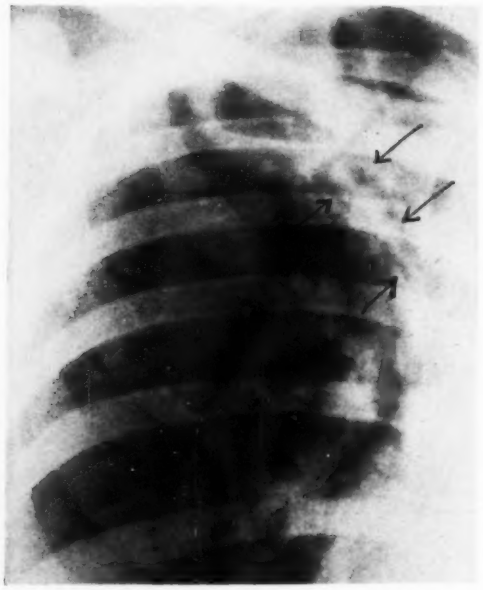

Fig. 9. Large area of involvement in the right apex and retroclavicular area, drained by several diseased bronchi.

entation of the uncomplicated and more easily recognized bronchial lesions. With close scrutiny, however, the radiologist will be able to pick out the diseased bronchi even in the presence of extensive surrounding pulmonary disease. Tomographic studies have proved to be of great value. In the absence of equipment for that procedure, Bucky studies are informative.

A summary of some of the clinical aspects of bronchial tuberculosis may be of value to the reader. A short verbatim excerpt from the excellent report by Riggins (9) is therefore presented.

"A tentative diagnosis of bronchial tuberculosis is warranted if any of the following symptoms or findings are present: positive sputum without demonstrable cavity; unilateral wheezing (is never asthmatic); lobar atelectasis or obstructive emphysema; cavities with fluid level; rapid and undue enlargement of a thin-walled cavity surrounded by relatively healthy lung, (positive pressure cavity), unexplained inability to close cavities with pneumothorax in the absence of extensive surrounding

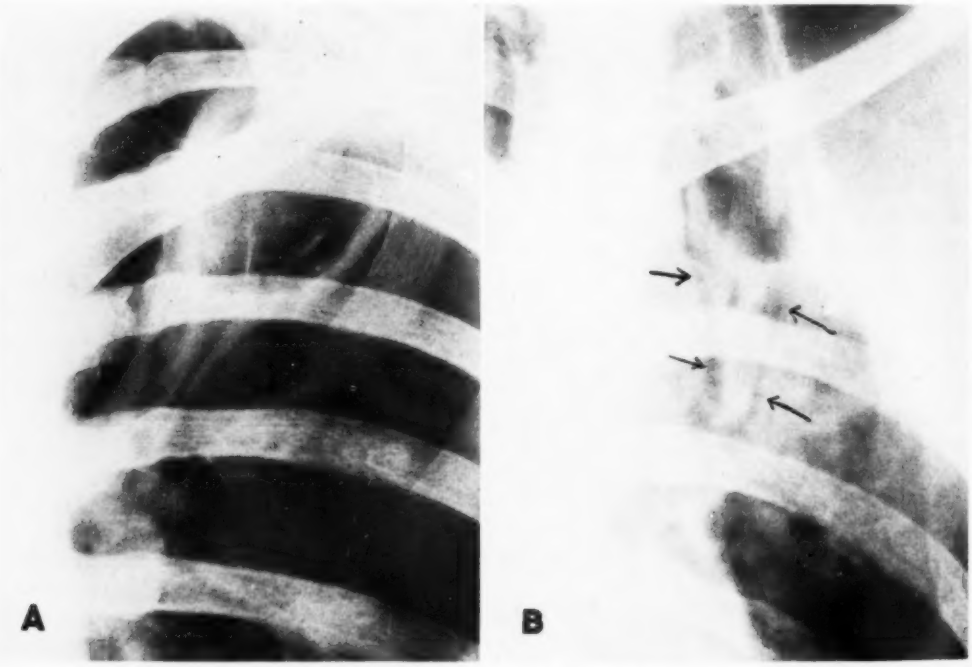

Fig. 10. A. Several bronchi may be identified as draining the diseased area in the left apex. Pneumothorax has not resulted in collapse of the cavity. B. The same cavity following thoracoplasty. It is compressed but not collapsed. The rigid bronchi are still plainly demonstrated.

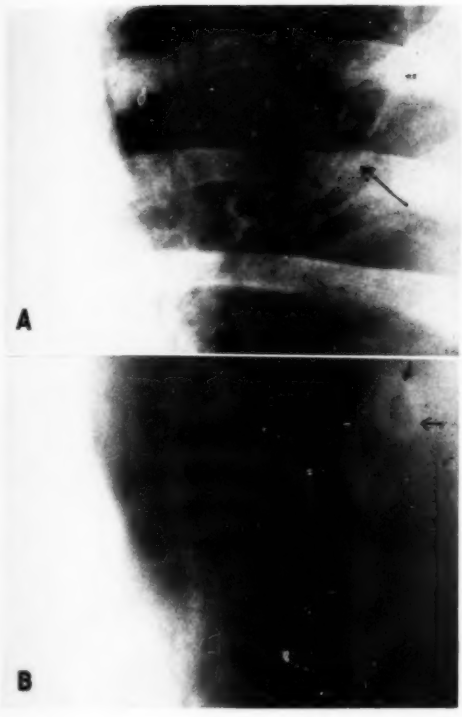

Fig. 11. No cavity can be seen on the routine study. The presence of visible bronchial markings suggests that a hidden cavity is being drained. B. Tomography confirms the presence of a draining cavity. The bronchus may be seen extending from the cavity toward the hilum. This could be seen better with transillumination of the film than the reproduction demonstrates.

caseation or adhesions; pendulum sway of the mediastinum in non-pneumothorax cases with bronchial stenosis and obstructive emphysema; undue dyspnea; harrassing or stridulous cough; wide variation in the amount of sputum; occasionally or persistently foul sputum; periodic febrile attacks unassociated with obvious cause (retention of secretions); recurring attacks of bronchopneumonia with negative sputum; and the development of bronchiectasis or acute putrid lung abscesses in patients with pulmonary tuberculosis."

SUMMARY

1. The lung shadows between a tuberculous cavity and the hilum contain the regional bronchi and the peribronchial vascular and lymphatic channels which drain the area of parenchymal involvement toward the lung root.

2. Heretofore the diagnosis of disease of the draining bronchi from tuberculous cavities was based upon clinical evidence, bronchoscopic findings, and circumstantial roentgen signs.

3. The roentgen shadows of the draining bronchi have a characteristic appearance, which permits an opinion as to their status.

4. The roentgen characteristics of the draining bronchi from tuberculous cavities are enumerated, with illustrated examples.

5. All of the cases presented were of proved tuberculous etiology. It is to be inferred, however, that the draining bronchi from non-tuberculous lesions may also be demonstrated.

ACKNOWLEDGMENT: My interest in this subject derives from an article on the pathology of tracheobronchial tuberculosis which was written by Dr. Gertrude Silverman (10) at the suggestion of Dr. H. McLeod Riggins. Dr. Riggins' keen clinical emphasis prompted me to independent roentgen observations. I wish to thank Dr. Richard H. Bennett for his interest and permission to use material from his medical service.

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A Study of the Ureters in Bladder Neck Obstructions[1]

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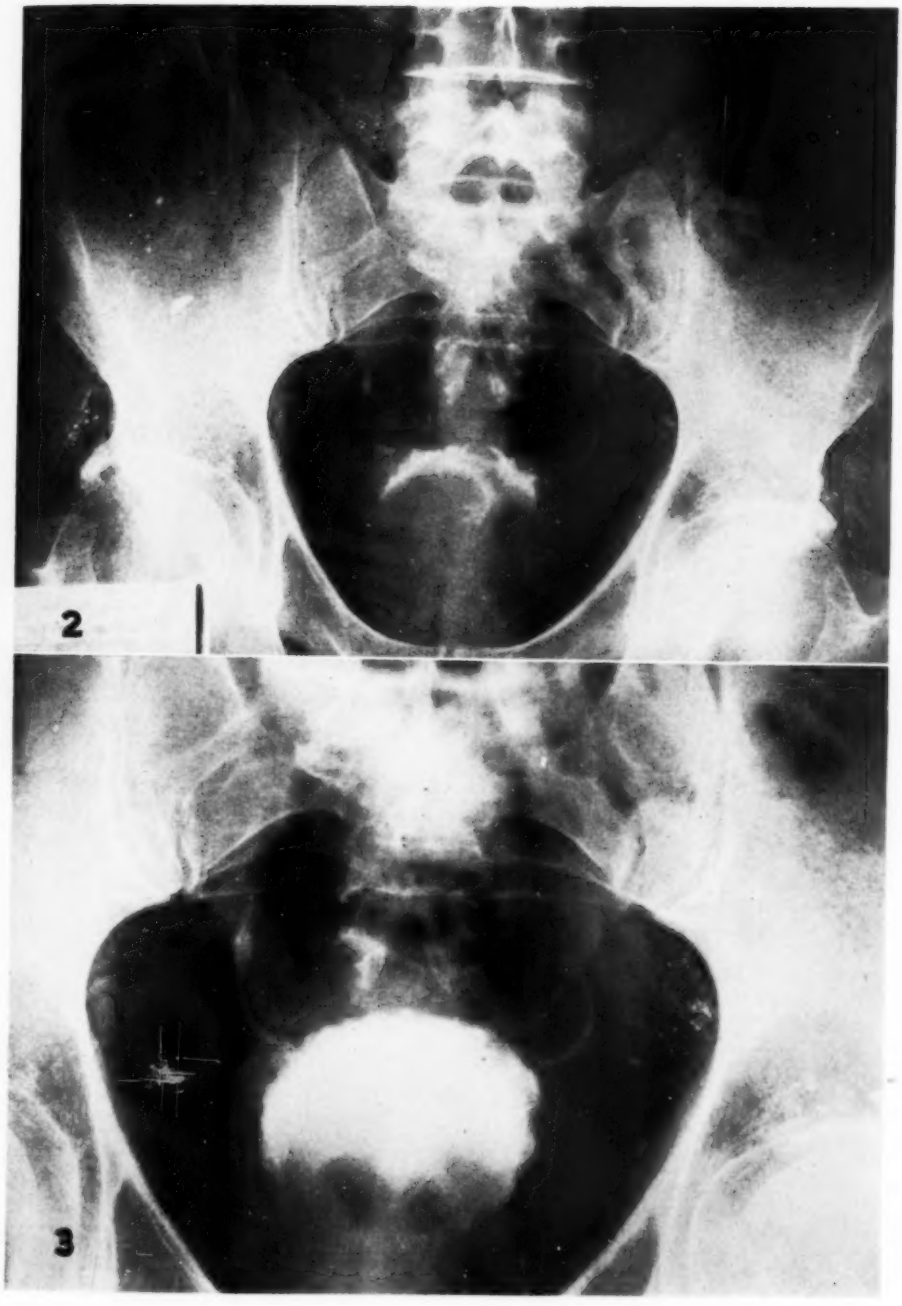
SOON AFTER THE introduction of intravenous urography, it was employed routinely in all cases of bladder neck obstruction on the service of one of the writers (H. L. K.). Early in its use we were impressed by the frequency with which hydronephrosis and hydro-ureter were found, and often in cases in which dilatation was not suspected. The routine use of intravenous urography revealed, also, other types of renal disease that was not suspected and hence would have been overlooked. We refer to malignant tumors and solitary cysts of the kidney. In patients with bladder neck obstruction who give a history of gross hematuria, one is likely to ascribe the bleeding to the obstruction, and hence reach an erroneous conclusion, thus overlooking a serious renal lesion.

As time has gone on and more and more patients have become familiar with the possibility of being relieved of obstruction by transurethral resection instead of open operation, with its lower mortality and morbidity, they now seek relief early rather than late in the course of their illness. Consequently, patients with large hydronephroses and hydro-ureters, large diverticula, and bladder stones are fewer in number.

Fig. 1. Tortuous left ureter.

As a result of our observations of the frequency with which these changes were found, we became interested in a study of the course of the ureter. This paper is in the nature of a preliminary report of this

[1] From the Presbyterian Hospital of Chicago. Read before the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.
[2] President of the American Medical Association.



Figs. 2 and 3. Right-angle turn of ureter emptying high in the bladder.

Fig. 4. Looping of ureter in pelvis before entering bladder.
Fig 5. Lateral displacement of right lower ureter.

study, being based upon a review of 120 films selected at random from the roentgen-ray department of the Presbyterian Hospital.

An interesting observation to which we should like to refer is the fact that in a relatively large number of patients the lower part of the ureter was not visualized. The reason for this we do not know. Because of this lack of visualization of the lower part of the ureter, it was necessary to review a great many films in order to obtain 120 in which visualization was present.

For purposes of presentation the cases were divided into two groups: those in which the course of the ureter was normal, and those in which there was some deviation from the normal course.

1. *Normal Course:* In 53 cases, or 44.16 per cent, the course of the ureter was normal. A study of the records disclosed that 48 of this group, or 90.56 per cent, had benign obstruction, and 5, or 9.43 per cent, had carcinoma. In other words, in nearly one-half of our cases, the course of the ureter was normal.

2. *Deviation from Normal:* This group forms the basis of this preliminary report. It includes 67 cases or 55.82 per cent of the total. Of this number, 60, or 89.55 per cent, had benign obstruction, and 7, or 10.44 per cent, had carcinoma.

A review of this group disclosed the following abnormalities in the course of the pelvic portion of the ureter:

Right-angle turn of ureter	25
Right-angle turn of ureter, high	4
Lateral displacement of ureter	
Marked	7
Slight	2
Looping of ureter	12
High entrance of ureter into bladder	4
Low entrance of ureter into bladder	2
Entrance of ureter at mid-line	2
Dilatation of ureter	
Marked	13
Slight	11
Tortuous ureter	3
Hydronephrosis	6
Normal course with dilatation	8
Normal entrance of ureter with lateral displacement	4

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Diagnosis of Pes Planus by X-Ray[1]

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BECAUSE of numerous complaints relative to the feet, among the Armed Forces, it was decided at this Station to conduct a survey of foot cases. Letters from officers stationed overseas led us to the conclusion that many men were being shipped out with foot conditions which caused them to become incapacitated, either partially or wholly, thus imposing a burden upon their organization and also sharply reducing their own personal morale. Men with minor symptoms relative to the feet and no gross physical foot deformity have many times been declared fully qualified for overseas duty on the basis of their particular jobs—clerks, technicians, etc.—on the ground that their work would not entail much marching or other physical stress. Owing to unforeseen circumstances, however, soldiers have often had to resort to foot marches when it had been anticipated that their movements would always be motorized. This has caused many with apparently insignificant foot disorders to manifest symptoms, ranging from those of a minor nature to incapacitation.

According to Ilfeld (1), approximately 50 per cent of those appearing before the CDD Board at the Station Hospital, Camp Callan, California, came because of orthopedic complaints, and of these one-third were foot complaints. Morton (2) has estimated the incidence of pes planus at as high as 40 per cent of the population. The great need of further information regarding the condition is indicated by this figure and by the known etiologic role of pes planus in the production of legache, backache, and arthritic involvement of the knees, hips, and spine.

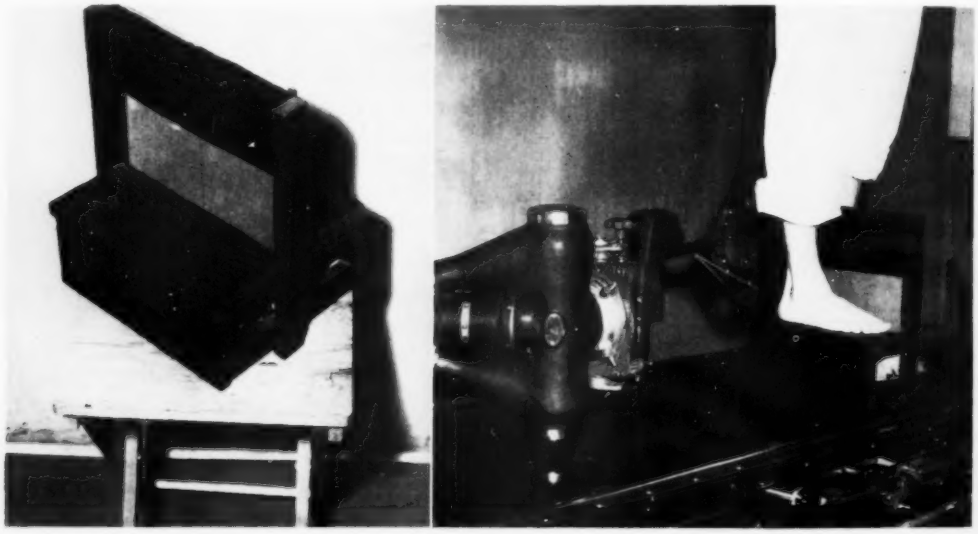

Fig. 1. Special film holder for weight-bearing examination.

In view of the above considerations, it was deemed desirable to set up a simple x-ray technic for examination of the feet, both in repose and during weight bearing (Figs. 1 and 2), whereby the actual position of the plantar arch and its deviation from normal could be accurately deter-

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mined. Accordingly, a simple film holder was constructed for the weight-bearing examination, and pedograms (footprints) were taken in each case, both in repose and during weight bearing, for comparison with the films. To determine the role of tarsal pronation, a weight-bearing anteroposterior view of the foot was also taken by the double-exposure method (Figs. 3 and 4). In each instance a case history was obtained with special reference to antecedent trauma and to rickets and other bone disease. An attempt was made to obtain a normal standard, deviations from which would indicate either pes planus or a pre-pes-planus status.

Fig. 2. Examination of feet in repose.

Before describing the actual method of measurement and presenting the results of our survey, a brief review of the salient features of pes planus seems pertinent.

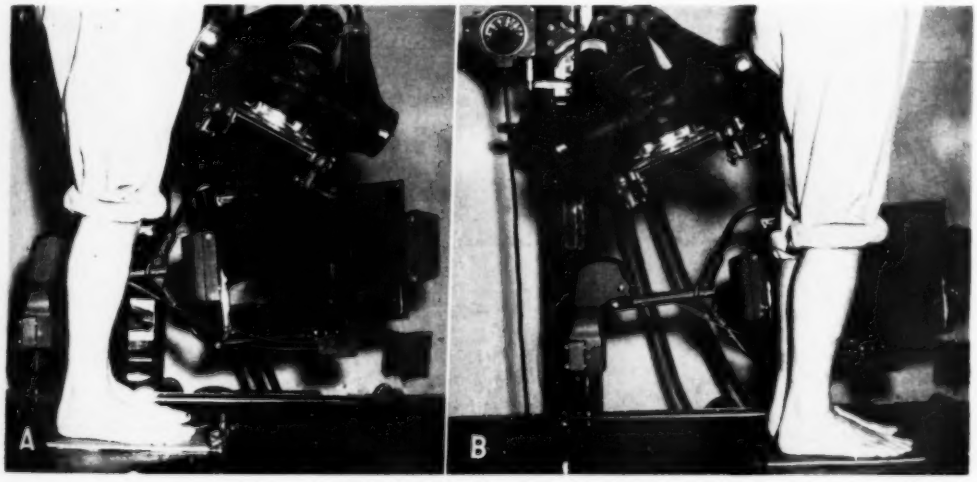

Fig. 3. Double-exposure method for study of tarsal pronation. A. First exposure. B. Second exposure.

Etiologic factors in pes planus include heredity, static defects, infections, occupation, obesity, posture, and injury. Heredity plays an important role and, according to Lewin (3), the paternal parent is usually the one responsible. Infectious diseases capable of producing toxic relaxations of the supporting structures of the foot may cause flatfoot and even arthritic involvement. Congenital anomalies such as an accessory scaphoid bone, fusion of the tarsal bones, and very rapid growth of the feet, are mentioned by Lewin as predisposing factors, although our survey revealed but few congenital defects. Poor posture may play a part. Obesity, by virtue of causing disproportion between the weight to be carried and the structure of the feet, is also to be considered. Fractures, sprains, improperly fitting shoes, and occupational trauma are known to contribute to the production of flatfoot.

Fig. 4. Roentgenogram of feet during weight bearing, double-exposure technic.

To understand the mechanism of production of pes planus, one must study the anatomy and visualize the stress applied. The structure of the foot is a classical demonstration of the law of functional adaptation for both static and dynamic function, according to Steindler (4). In simple terms the foot consists of an arch resting on two pillars, with a superincumbent weight on the keystone of the arch. The anterior pillar consists of the metatarsal heads; the posterior pillar is the os calcis, and the keystone the astragalus. Actually there are two arches which meet at the subastragaloid articulation: the inner arch, which satisfies the primitive dynamic demand, runs forward over the neck and head of the astragalus, scaphoid, three cuneiforms, and three inner metatarsals, to the heads of the latter, and backward over the articular process of the os calcis to the heel proper. The outer arch modifies the mechanical structure, allowing flexibility; that is, it controls side-swaying movements. This outer arch runs forward over the cuboid and outer metatarsals and backward to the os calcis. The keystone (astragalus) is placed slightly medial, with a consequent tendency to slide inward and downward.

The axes of the joints of the foot are: (1) the ankle joint, that is to say, the tibioastragaloid articulation, which runs obliquely to the axis of the knee joint from outward and backward to forward and inward, allowing flexion and extension; (2) the subastragaloid articulation, which runs from backward, outward, and downward, to forward, upward, and inward, allowing pronation and supination; (3) the three axes of the midtarsal joint. These latter are the sagittal, which allows pronation and supination of the forefoot against the back foot; the vertical axis, which allows abduction of the forefoot against the back part of the foot; and the front axis, which permits flexion and extension of the forefoot against the back part of the foot.

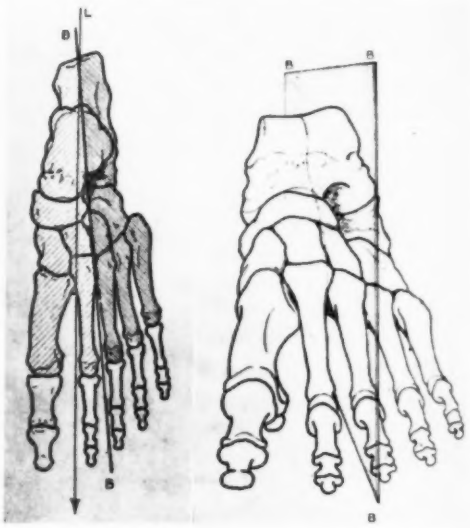

Fig. 5. Relation of leverage axis to axis of balance. The long arrow (L) represents the leverage axis. BB is the axis of balance. The plane of balance, BBB, is shown in the drawing on the right. Reproduced from Morton's "The Human Foot," by permission of the Columbia University Press.

According to Morton's investigation of the foot with a staticometer, there is a functional axis, which he terms the "axis of balance," running from the center of the heel

forward between the second and third metatarsals, and a "leverage axis," extending between the first and second metatarsals (Fig. 5). He considers the foot not as a single unit, but divides it into five individual arcs conforming to the metatarsals which, when viewed laterally, are shown to be each of a separate height and length (Fig. 6).

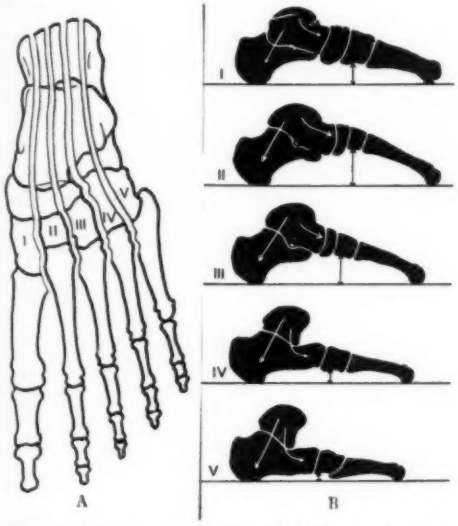

Fig. 6. Metatarsal segments of the foot. A. Suggested physiological division of the foot into longitudinal segments conforming to the metatarsal bones. B. Side view of segments with arrows to indicate the direction of weight transmission. Reproduced from Morton's "The Human Foot," by permission of the Columbia University Press.

By means of the staticometer, it is seen that the weight-bearing distribution upon the foot is proportionately as follows: os calcis 3, first metatarsal 2, second, third, fourth, and fifth, 1 each (Fig. 7).

The integrity of the foot is entrusted to the bony architecture, ligaments, and muscular apparatus. The *ligaments* which are important at the astragalotibial joint are the internal and external deltoids, controlling lateral stress; at the subastragaloid joint, the calcaneo-scaphoid, which prevents forward and downward gliding of the astragalus on the inner arch of the foot; at the remaining articulations, the calcaneocuboid, stellate, and radiate ligaments. Thus, the posterior foot is rigid

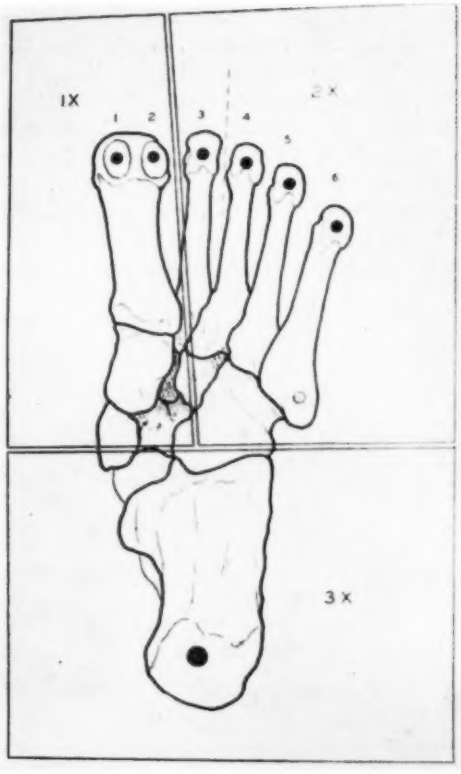

Fig. 7. Weight distribution upon the foot in stance. The black dots indicate the points of bony contact and support afforded by the metatarsal bones (and sesamoids) anteriorly and by the heel posteriorly. Little if any weight is usually borne by the base of the fifth metatarsal. The normal ratio of weight distribution in this position is 1×:2×:3×. The broken line indicates equal division of weight normally transmitted upon the fore part of the foot. Reproduced from Morton's "The Human Foot," by permission of the Columbia University Press.

and the anterior foot mobile, allowing the metatarsals and digits to adapt themselves to the supporting surface which they grip while the posterior foot deploys from the surface in walking (5).

As to the *muscles*, in the ankle joint plantar flexion is controlled by the soleus and gastrocnemius-plantaris assisted by the flexor hallucis longus, tibialis posticus, and peroneus longus. Dorsiflexion of the ankle is controlled by the tibialis anticus, the extensor digitorum, and the peroneus tertius. The subastragaloid joint depends for supination upon the tibialis posticus, assisted by the flexor hallucis longus and

common flexors of the toes. For pronation, the peroneus longus and brevis, assisted by the common extensor digitorum and peroneus tertius, are involved. The calcaneo-astragalo-scaphoid joint depends for pronation upon the peroneus longus and brevis, extensor digitorum longus, and peroneus tertius; for supination, upon the tibialis posticus and anticus, flexor digitorum longus, flexor hallucis longus, and one in the back, which is controlled by the anterior muscles. The subastragaloid joint is peculiar in that the astragalus is placed in an eccentric position on the os calcis. This keystone bone, therefore, shows a tendency to slide downward and forward, resulting in pronation of the os calcis.

If the astragalus is allowed to slide forward, the whole foot will tilt over into pronation, the arch will flatten, and the

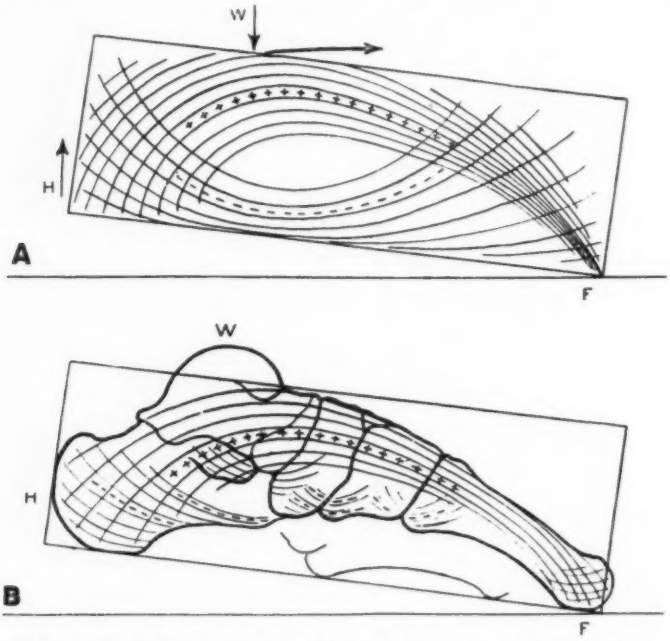

Fig. 8. Design of the arch in relation to leverage. A. Stresses affecting a block when it is used as a lever. B. Outline of the arched inner border of the human foot sketched on the block to show how it conforms in contour and in trabecular arrangement with the mechanical stresses of leverage. Compression stresses are indicated by +++; tensile stresses by ———. Reproduced from Morton's "The Human Foot," by permission of the Columbia University Press.

extensor hallucis longus. The metatarsal phalangeal joints show minimal motion in abduction by means of the abductor hallucis and interossei, extension by the short and long extensors, and flexion by the long and short flexors.

Muscle equilibrium plays a part in the prevention and production of flatfoot. The tibio-astragaloid joint has three lines of gravity; one through the center, where there is no muscle action; one in the front, which the tendon of Achilles must hold; inner border of the foot will become convex. This is the classical picture of flatfoot. The duty of the tibialis posticus and anticus and the toe flexors is to prevent this from happening. The tension of the peroneus longus is a further preventive factor.

Muscle dynamics in regard to the foot is synonymous with the act of propulsion. The foot is placed on the ground, with the heel first and toes extended. It then rolls over the outer border until the contact

reaches the ball of the foot. The toes then grip the surface to provide a fixed point so that the body may be pulled forward. This latter is done by flexion associated with supination of the subastragaloid articulation and abduction in the midtarsal joint. With each pronation motion of the back of the foot, there is a compensatory supinatory rotation of the forefoot, which is especially noted in flatfoot (4).

The lifting force in walking is exerted at the heel and passes forward and upward in a curved direction toward the keystone of the arch, whence it curves downward and forward to the metatarsal heads, which serve as a fulcrum. These lines of force are to be found in the distribution of the trabeculae of the bones of the foot and are identified as compression stresses (Fig. 8). Since the bony architecture of the foot is segmented, the lines of force are broken by the intervening joints. Counteracting tensile stresses are arranged in secondary systems in each bone involved, and the continuity is made possible by the plantar ligaments and fascia (1).

The principal joints involved in weak and flat feet are the subastragaloid and midtarsal articulations. In the weak foot, normal equilibrium is merely threatened, not actually disturbed, while in flatfoot, equilibrium is disturbed and morphological changes due to the relaxation of the ligaments and muscles have ensued. The astragaloscaphoid joint is altered by a deforming force consisting in the rotatory component of the upper pressure applied to the center of the ball of the foot. This causes an upward movement of the forefoot against the back part of the foot, resulting in rotation of the astragalus downward and inward while the toes and metatarsals rotate upward and outward.

Shanks, Kerley, and Twining (6) noted the following morphological changes in cases of pes planus: "(1) The scaphoid and cuboid slip downward. The scaphoid may be wedged, and the upper part of the joint space between it and its neighbors may be widened. (2) The astragalus appears foreshortened, with a prominent anterior and upper margin. Its anterior extremity is depressed."

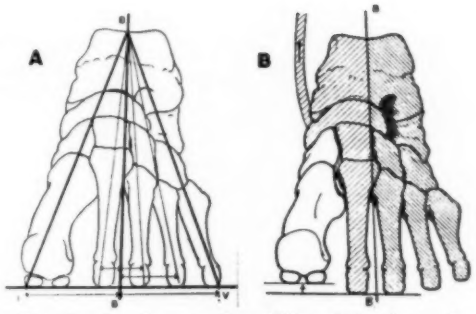

Fig. 9. A. Structural stability of the foot. Anterior view with the axis of balance (BB) in normal position between the second and third metatarsals. The first and fifth metatarsal bones furnish an equally wide margin of stability on each side of the foot (IB and BV).

B. Hypermobility of first metatarsal segment. The first metatarsal and internal cuneiform bones are unshaded to denote their ineffectiveness (through hypermobility) to contribute to the medial stability of the foot. The resulting pronation causes body weight to become concentrated upon the second metatarsal and continues until restricted by the muscles on the inner side of the ankle, or until the first metatarsal gains a firm contact with the ground.

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It is our opinion that these changes take place as the result of compensation when the pes planus status is of extended duration. Many of the cases surveyed showed these morphological changes, which may, we believe, later lead to true arthritic states both locally and in distant joints, as a result of the alteration of the weight-bearing axes.

In the subastragaloid joint, the astragalus glides forward and downward, causing flattening of the arch and convexity of the inner border. This "break" in the middle of the foot is due to the fact that the heel is a fixed point and the ball a fixed area. As the astragalus moves forward and inward, the os calcis is forced to follow it and pivots about its point of posterior support so that the whole posterior foot becomes pronated. This is not possible in the forefoot, because of the broad area of contact. Thus, the forefoot is in relative supination and dorsiflexion as compared to the back part of the foot.

According to Morton, pronated feet show a concentration of body weight upon

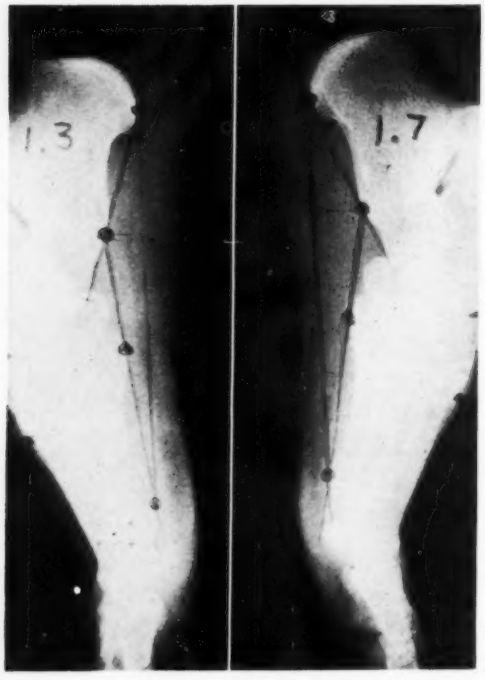

Fig. 10. Roentgen measurement of the arch during repose.

the head of the second rather than of the first metatarsal, resulting in several criteria for diagnosis. These criteria, demonstrable by x-ray, are: (1) an elongated second metatarsal as compared with the first; (2) broadening of the shaft of the second metatarsal as compared with the fourth; (3) increased separation between the internal and middle cuneiforms; (4) sesamoids over the first metatarsal located proximal to the head.

Elongation of the second metatarsal and/or proximally placed sesamoids of the first metatarsal showed no apparent variation on the staticometer with the subject standing, but a kinetograph revealed a heavy concentration of weight on the second metatarsal during walking, apparently the result of leverage stresses. Broadening of the shaft of the second metatarsal is probably due to a compensatory hypertrophy as a result of an abnormal increase in function. Increased separation between the internal and middle cuneiform is an indication of hypermobility of the first metatarsal segment, which consists of the first metatarsal, internal cuneiform, and the internal third of the scaphoid, as illustrated in Figure 6. This hypermobility results in the second metatarsal carrying the burden of the first, a tendency of the foot to roll inward, since the first metatarsal fails to act as a buttress, and an increase in the stress of the muscles of the internal side of the ankle (Fig. 9). Bingham found 10 per cent of patients in his clinic complaining of painful feet to have "Morton's syndrome" (7).

As observed by many investigators, footprints are of doubtful value in estimating the degree of pes planus. Our investigation showed that footprints (pedograms) are reliable for determining the degree of pronation but not of the actual descent of the arch.

The symptoms of flatfoot are fatigue, pain, and aching, commonly referred to as tarsalgia. Varying areas of tenderness are found over the tarsal area. Theoretically, disturbances in weight bearing secondary to alteration of the plantar arch would be definite factors in the etiology of arthritic involvement of the knees, hips, and spine. That this theory is correct is believed by numerous clinicians, and many of us have seen chronic back pain ameliorated by correction of a co-existing pes planus.

In our x-ray survey, we measured the distance from the base to the apex of the triangle formed by lines extended along the plantar aspect of the foot laterally. The base extended from the head of the fifth metatarsal to the posterior plantar angle of the os calcis. The posterior side of the triangle connected the plantar eminences of the os calcis, and the anterior side extended from the plantar aspect of the head of the fifth metatarsal through the plantar aspect of the proximal end of the fifth metatarsal, as illustrated (Figs. 10 and 11). This method of measuring the longitudinal arch was chosen because of its simplicity and because the points involved are easily visualized. The results approached those obtained by Moreau and Costa Bertani (8)

with their method of measuring various angles of the plantar aspect of the foot.

For a part of our survey the internal longitudinal arch was used as an indicator. The measurement of the internal arch was quite consistent with the more easily established measurement of the outer arch, which foot it is believed is a true indicator of degree of involvement.

Pronation was determined on the basis of pedograms in repose and during weight bearing and double-exposure weight-bearing x-ray examination, as illustrated in Figure 3. According to Ilfeld, pronounced pronation of the foot may be present without symptoms. Two per cent of his series of patients with normal feet presented third-degree clinical pronation and 15 per cent showed second-degree pronation (1). In view of these observations, we concluded that an x-ray examination in the presence of foot complaints is a very necessary procedure inasmuch as many discrepancies are noted between the clinical and x-ray diagnosis.

Study of the tarsal internal cuneiform scaphoid joint in the clinical examination was found to lead to a diagnosis tallying with the x-ray diagnosis more frequently than the usual method of using the tarsal scaphoid as an indicator. The tarsal internal cuneiform descends in relationship to the scaphoid rather than *vice versa* in a case of pes planus. We arbitrarily set up a standard of arch measurement of 1 cm. or more during weight bearing as necessary to exclude pes planus.

It was noted that in many cases the arch was normal in repose but showed a rather marked descent during weight bearing. These cases could properly be termed, pre-pes planus or, in some cases, merely foot strain. Patients whose measurements were below the average in both repose and weight bearing were found to have fewer symptoms, in general, than those designated as pre-pes planus, presumably due to the stretching of the foot structures in cases of the latter type, whereas an already developed flatfoot was more or less compensated.

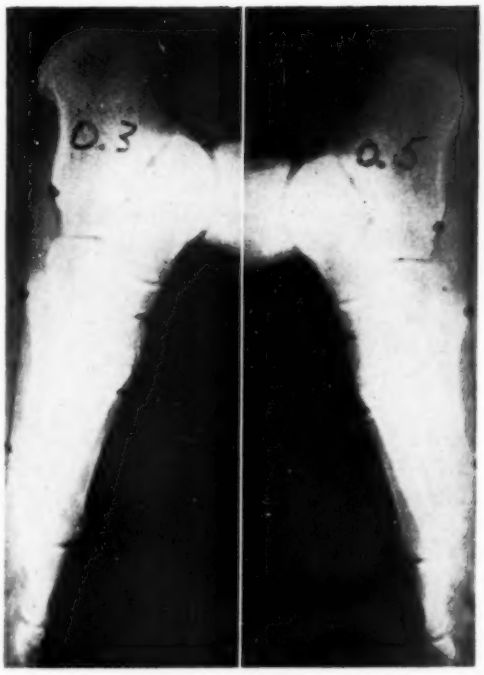

Fig. 11. Roentgen measurement of the arch during weight bearing.

Methods of therapy are many, but fall into two main groups: (1) those which tend to lift the arch and (2) those which are designed to lift the heads of the metatarsals.

Morton's method of building a lift under the heads of the metatarsals which, by failure to contact the surface, escape their share of foot stress, is an example of the latter group. Of 100 soldiers treated by this method in Bingham's series (7), 76 were sufficiently benefited to return to full military duty. Theoretically, the best of the methods designed to lift the arch seems to be that calling for a plastic plate encased in a leather pouch which is inserted in a shoe over the arch and heated with a current until the plastic becomes pliable. The patient then walks with the device in place and, by virtue of actual use, molds the plastic to fit the foot. After five minutes, the plastic becomes hardened and serves as a minor support until the arch has been forced up to a slightly higher position. The whole procedure is then re-

peated and by further repetitions the arch is theoretically replaced to a more nearly normal anatomical position.

Lack of ability to make follow-up studies on the patients surveyed prevents any definite conclusion as to proper therapeutic methods.

In those cases of our series without pes planus the x-ray measurements showed variations between 1.0 and 3.0 cm. in repose, with the average at about 1.9 cm. During weight bearing, the variation was from 1.0 to 2.3 cm., with an average of about 1.1 cm.

In cases with x-ray evidence of pes planus the variation in respose was between −0.5 cm. and +3.0 cm., with the average at about +1.3 cm.; during weight bearing, from −0.6 cm. to +0.9 cm., with the average at about +0.8 cm.

Measurements during weight bearing were arbitrarily set up for correlation with the clinical diagnosis, in degrees, as follows: normal, 1.0 cm. or above; first-degree pes planus 0.7 to 0.9 cm.; second-degree pes planus, 0.4 cm. to 0.6 cm.; third-degree, 0.2 cm. to 0.3 cm.; fourth-degree, −0.1 to +0.1 cm.

Of the cases clinically appearing to be normal, 83 per cent showed x-ray evidence of pes planus; 77 per cent, however, were either normal or of less than third degree. Thus, 23 per cent were pathological according to Army standards. Of the cases clinically showing first-degree pes planus, 9 per cent were declared normal on the x-ray examination, 36 per cent first-degree, 39 per cent second-degree, 7 per cent third-degree, and 9 per cent fourth-degree. Of the cases clinically showing second-degree pes planus, 9 per cent were normal by x-ray standards, 36 per cent first-degree, 35 per cent second-degree, 15 per cent third-degree, and 5 per cent fourth-degree. Of third-degree cases, from a clinical aspect, 8 per cent were found roentgenologically to be normal, 25 per cent first-degree, 46 per cent second-degree, 15 per cent third-degree, and 6 per cent fourth-degree. There were no cases clinically diagnosed as of fourth degree.

These findings are summarized in the accompanying table.

TABLE I: COMPARISON OF CLINICAL AND ROENTGEN FINDINGS

Clinical Diagnosis	Roentgen Diagnosis				
	Normal	First-Degree	Second-Degree	Third-Degree	Fourth-Degree
Normal	17%	24%	37%	16%	6%
First-Degree	9	36	39	7	6
Second-Degree	9	36	35	15	5
Third-Degree	8	25	46	15	6

Pronation studies led to the following observations. Of the cases which appeared clinically and roentgenologically negative for pes planus, 57 per cent showed pronation on films and pedograms. Sixty-five per cent of the cases diagnosed clinically as pes planus were negative for pes planus on x-ray examination but showed pronation. Of the cases with x-ray evidence of pronation, 61 per cent were negative for pes planus, 17 per cent showed first-degree pes planus, 10 per cent second-degree, and 5 per cent fourth-degree.

Forty colored patients and 360 white patients were examined, which is approximately the proportion assigned to this field. Of the colored group, 90 per cent showed evidence of pes planus, as compared with 72 per cent of the white group. It is believed that these percentages may be roughly correct for an over-all survey.

Patients 10 or more pounds overweight constituted only 34 per cent of the total with pes planus; of those without pes planus, 46 per cent were 10 or more pounds overweight.

A history of foot injury was obtained in 28 per cent of those with evidence of pes planus and in 33 per cent of those without.

The age incidence is as follows, though these figures are probably misleading, since the majority of military personnel fall in the age group 20 to 30:

15 to 20 years	7%
20 to 25 years	40%
25 to 30 years	24%
30 to 35 years	19%
35 to 40 years	8%
40 to 45 years	2%

Half of the cases surveyed were observed, also, for "Morton's foot" (short first metatarsal, etc.). Of this group, 42 per cent had pes planus without evidence of "Morton's foot"; 12 per cent of those with "Morton's foot" showed no evidence of pes planus.

CONCLUSIONS

On the basis of the clinical history, physical examination, and x-ray examination of 400 subjects, it is felt that the following conclusions may be drawn:

1. That many persons appearing to have normal arches but complaining of foot distress may have a basis for their symptoms, if the x-ray findings in this survey can be accepted as an indication of structural defects.
2. That the measurement of descent of the lateral arch, using the 5th metatarsal and the os calcis, may constitute an index of the degree of pes planus.
3. That pronation and pes planus may be coexistent or present individually.
4. That "Morton's foot" (short first metatarsal, etc.) may or may not coexist with x-ray evidence of pes planus.
5. That an arbitrary standard of 1 cm. for the height of the lateral longitudinal arch is the most practical for separating those cases which may be designated as pes planus from those which may not. This conclusion is based on the number of cases falling above and below this measurement in this survey.
6. That, in this survey at least, the incidence is higher among colored persons (90 per cent) than among whites (72 per cent).
7. That, contrary to the findings of other investigators, overweight (10 pounds or more) did not seem to be a factor in the incidence of pes planus.
8. That pes planus is an important physical condition resulting in far-reaching body changes and should be given more recognition by both radiologists and the general medical profession.

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CLINICAL NOTES

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Captain Bonnet has asked that I discuss the clinical application of this survey. It has been my opportunity to see a majority of the cases studied. These comprised all types of foot and arch deformities and so-called normal feet, as well as frank cases of flatfoot. Both sexes are included.

It is clear that if the measurements obtained from the x-rays can be accepted as an adequate determination of the presence or absence of pes planus, one's clinical judgment is seldom correct. This is demonstrated by the finding of pes planus in 83 per cent and pronation in 57 per cent of so-called clinically normal cases. At first, I was skeptical of the findings, because the measurements were made from the lateral aspect of the plantar arch. When, however, measurements were made on the same films, using the medial aspect of the arch, the difference was found to be negligible.

The study has been of inestimable value in differentiating between pes planus and pronation and in borderline cases of pes planus in respect to duty assignments. It is my feeling that such studies are indicated in order better to evaluate and treat all cases of painful feet in which some defect of the plantar arch is suspected.

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Pneumoconiosis Due to Cotton Dust (Byssinosis)[1]

A Case Report

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BYSSINOSIS, a form of pneumoconiosis due to prolonged inhalation of cotton dust, has long been recognized as a cause of ill health among British cotton-mill workers. In 1936, C. Prausnitz (2) and co-workers, under the auspices of the British Medical Research Council, published an account of their extensive investigations into the causes of respiratory disease in this industrial group. A brief review of this work follows.

Sickness caused by respiratory disorders is frequent in cotton mill operators, particularly those working in departments in which there is a continuously high content of cotton dust in the air. Many operators working in such departments experience a typical illness, referred to as "stripper's asthma" or "cotton-mill fever," an insidious disease characterized initially by evidence of upper respiratory irritation with moderate fever. The first attack soon subsides, but with continued employment in this type of work a dry irritating cough and attacks of breathlessness develop, with a sense of constriction in the chest. These symptoms are aggravated on return to work on Mondays after a week-end of absence from the mill. In a period of years, symptoms become more severe; "Monday-morning fever" continues into later days of the week, with aggravation of symptoms. The cough grows worse, becoming spasmodic, with production of small quantities of sticky, tenacious sputum. If the affected person quits the mill before symptoms become too severe and enters some type of out-of-door work, these disappear and health is regained. If, however, he remains in the same type of employment, he becomes progressively worse, with a prospect of invalidism with emphysema, bronchitis, and ultimate cardiac failure. Fletcher, co-worker of Prausnitz, examined radiographically 100 persons with "mill fever." He describes the appearances as those of chronic bronchitis with associated emphysema; there were no particular roentgen features specific for the disease.

A short summary of the findings and experimental observations of Prausnitz and his co-workers follows:

1. Card-room air of cotton mills is rich in dust particles less than 2 microns in diameter and still richer in ultramicroscopic particles capable of easy penetration into deep air passages.

2. The protein fraction of cotton dust has an irritating effect upon the deeper tissues of the lungs and produces definite inflammatory lesions. Animals subjected to prolonged inhalation of cotton dust showed marked thickening of the interalveolar septa as a result of edema, leukocytic and dust cell infiltration.

3. Patients working in cotton mills who develop "card-room fever" all become hypersensitive to cotton-dust protein. Evidence of anaphylaxis could be produced by intracardial injection of cotton dust into animals which had been previously sensitized by parenteral injection of the cotton-dust protein or by prolonged inhalation of the dust itself.

4. Physiological tests showed definite impairment of respiratory function in a large portion of cotton workers suffering from respiratory diseases.

The British workers conclude that it is important that persons complaining of respiratory diseases be removed early from the injurious working conditions (high cotton-dust air content) before secondary changes develop in the lungs.

Trice (3) and Bolen (1) have written of the hazard of byssinosis in America and suggested means of prevention. Bolen reviews the literature.

[1] Accepted for publication in May 1945.

CASE HISTORY

A white male, 21 years of age, a native of a southeastern state, entered the hospital on Jan. 13, 1943, ten weeks after induction into the Army. For several days he had not felt well, because of a cold. On admission, he complained of weakness, sore-throat, chills, cough, and pain in the chest. His temperature was 102.2° F., pulse 104, and respirations 32.

The patient stated that he had not been very well for several years. His only definite illness, however, during that period had been an attack of "flu" in 1938, at which time he was sick for one week. He had a similar illness in the spring of 1940, with loss of several days from work. On recovery he had returned to his place of employment, where he had remained as an employee until induction.

In January 1940, the patient had started working in a cotton mill, where he was employed as a quilling machine operator in a weaving room. In this room there was always a fine, misty dust, which settled on the looms and other machinery. At intervals the looms were cleaned with an air hose, and at such times the air of the room became very dusty. The patient did this type of work on several occasions as a spell job. He stated that, after working in the mill for six or eight months, he asked for a lighter type of work, not feeling up to the duty to which he was then assigned. Such an adjustment was made, and he got along rather well.

The family history was irrelevant with the exception that a sister suffered from asthma.

The patient was a well formed young man, rather slender, not appearing particularly sick and with no gross abnormalities. The membranes of the nose and pharynx were moderately injected. Repeated examinations of the chest during his hospital stay showed no abnormal findings. The rest of the physical examination was essentially negative.

A roentgenogram (Fig. 1) taken shortly after admission revealed large patchy densities throughout both lung fields. These were at first thought to be associated with the upper respiratory infection from which the patient was suffering, but though he recovered from his illness within three or four days, the roentgen appearance remained unchanged for a period of two months, during which he was under observation. For an interval during this time, he was receiving potassium iodide therapy.

With the exception of a slightly increased sedimentation rate, all laboratory studies were negative. These included spinal fluid examination, a blood Kahn test, blood culture, repeated sputum examinations for tubercle bacilli, and several for fungi. The red blood cell count was 5,000,000, the white cell count 8,800, with 80 per cent polymorphonuclears and 20 per cent lymphocytes. The urine was normal. The blood sedimentation test one month after admission was 14 mm. in thirty minutes and 27 mm. at the end of one hour. An old tuberculin intradermal skin test was negative.

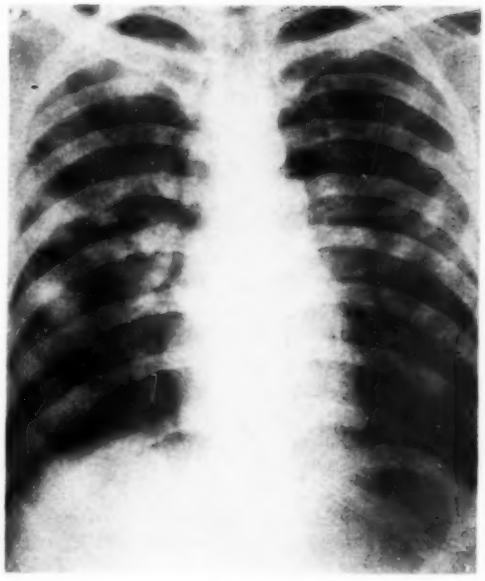

Fig. 1. Roentgenogram showing large patchy densities throughout both lung fields.

SUMMARY

This case is presented as one of pneumoconiosis (byssinosis) due to prolonged inhalation of cotton dust. The diagnosis is based on the history of employment as a cotton-mill worker for a period of about three years just prior to hospital admission, together with an analysis of the clinical history and the patient's activities during this period. For the two months he was under observation, the findings as seen in the chest roentgenogram made on his admission for a minor respiratory ailment remained unchanged. These we can only explain as due to byssinosis.

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An Unusual Case of Multiple Chondromata[1]

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MULTIPLE chondromata involving the hands and feet are not common, while involvement of a long bone in addition to the hands and feet was present in only 3 of Geschickter and Copeland's series of 71 cases (1, *a*). In a careful study of the literature no record was found of skeletal changes as extensive as those in the case reported below, although several instances of multiple chondromata have been described (2, 3, 4).

CASE REPORT

The patient, who gave his age as 21, but looked younger, was asked to come into the dispensary for study when marked deformity of his hands and arms was observed. His mother stated that his birth was normal, and that he was breast-fed for one year. Cod-liver oil was administered in small amounts (exact quantity not known) beginning at 16 months of age. When the boy was approximately two years old, his mother noticed that his hands were deformed. A local doctor made a diagnosis of rickets and advised large doses of cod-liver oil, but no improvement resulted. The patient states, curiously enough, that he was not conscious of the deformity of his hands and arms until he was fourteen years old. He is certain that since then there has been no change in their appearance. He avoided athletics in high school, but otherwise his activities were not restricted. He studied stenography and became sufficiently proficient to type 60 words per minute. He is now employed in the capacity of a clerk.

At the age of 7 he had scarlet fever without complications. In 1939 he fractured his right femur in a sleighing accident, but no evidence of the fracture is seen on x-ray examination at this time. In 1943 tonsils and adenoids were removed. For several months prior to this, fleeting pain occurred in various joints, but this disappeared shortly after tonsillectomy.

The patient's mother is 61 and has "heart trouble." His father is 62 and well. He has four brothers and four sisters, all of whom are well except one brother, who has a peptic ulcer. No visible deformity similar to his is present in any other member of the family. Unfortunately the other members of the family could not be x-rayed.

Physical Examination: The patient is 5 feet 8 inches tall and weighs 125 pounds. His skin is clear and no hemangiomas are present. His shoulders are narrow and drooping, the left more than the right, with shortening of the upper and lower arm. The muscle development is normal and strength good. The upper left arm from the acromion to the head of the radius measures 18.75 cm. and the right upper arm 20 cm. The left lower arm from the head of the radius to the styloid process is 20 cm. long and the right lower arm between the same anatomical points measures 22.5 cm. (Fig. 1).

Fig. 1. Photograph of patient showing short left arm and deformed hands.

Both hands are markedly deformed. Hard fixed nodules, from 1 to 2 cm. in diameter, are palpable on the dorsal surface of the right second, fourth, and fifth metacarpals and on the proximal phalanx of the thumb. Similar nodules are present on the interdigital surfaces of the proximal and middle

[1] Accepted for publication in February 1945.

Fig. 2. Deformity of the fingers due to chondromata in the proximal and middle phalanges.

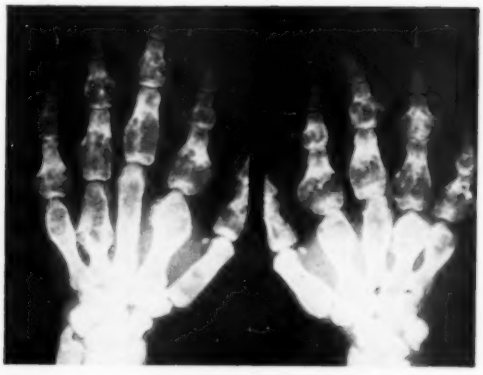

Fig. 3. Roentgenogram taken in December 1944, showing multiple chondromata involving the metacarpals and proximal and middle phalanges. Compare with Figure 4.

phalanges of all the fingers. When bilateral, they give the finger a fusiform appearance. On the left hand, similar nodules are present on all the metacarpals, proximal and middle phalanges of the fingers, and proximal phalanx of the thumb. The skin is movable over these nodules and none is tender to pressure. The nails appear normal. The left middle finger is deviated medially, and flexion of the left hand is incomplete (Fig. 2).

The second toe on the left foot is everted, and the third toe is short. The fourth toe on the right foot has a firm nodule on its lateral aspect.

The patient has a light beard but no axillary hair. The first lower molar on the left and second lower molar on the right have been extracted. The remaining teeth appear normal. Aside from a moderate sized varicocele on the left, other physical findings are normal.

Laboratory Findings: Blood studies show hemoglobin 15.6 gm., red cells 5,800,000, white cells 4,800 (polymorphonuclears 28, lymphocytes 66, stabs 1, monocytes 4, basophils 1). The urine has a specific gravity of 1.010, with no albumin and no sugar; microscopic examination is negative. The blood phosphorus (5.2 mg. per cent) and phosphatase (15.7 Bodansky units) are slightly elevated; blood calcium (11.2 mg. per cent) is within normal limits. None of these findings is suggestive of hyperparathyroidism.

X-Ray Examination: Roentgenograms of the hands reveal a remarkable picture. All the metatarsals and proximal and middle phalanges of the hands show central translucent and rarefied areas with visible trabeculae, at times giving a honeycomb appearance. The cortex is thin and expanded. The distal phalanges seem to be spared except for the left middle finger. The picture is one of multiple chondromata (Fig. 3).

Through the courtesy of Dr. L. G. Allen, a roentgenogram of the patient's hands taken in December 1939 was obtained (Fig. 4). The report reads: "These films show broadening of the shafts of the metacarpals and phalanges with cyst-like expansion of the shafts at the diaphyseal extremity . . . . Deformity of the fingers is the result of this cyst-like deformity of the bones. The picture is that of multiple enchondromata. No spurs of the cortex are demonstrated and the articular surfaces are uninvolved." A comparison with the more recent films (Fig. 3) shows no striking change in the appearance of the bony lesions during the five-year interval. There has, however, been an increase in length and width of the metacarpals and phalanges.

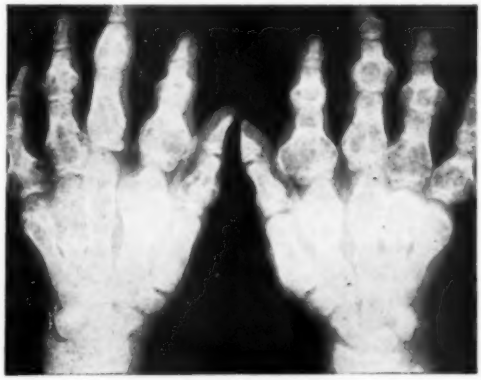

Fig. 4. Roentgenogram of the hands taken in 1939. Comparison with a more recent film (Fig. 3) shows little change in appearance of the lesions over a five-year period.

The findings in the shoulder region are equally striking. The coracoid processes are translucent, with fine trabeculae. The upper part of both humeri are widened and show severe distortion of

the bony architecture. Striae and mottling are marked, and scattered rarefied areas can be seen. There is disruption of the thinned cortex proximally, especially noticeable on the right. The medullary canal is widened throughout. Horizontal and longitudinal striae are present in the medulla of both humeri, and on the left the cortex is thin and expanded (Fig. 5).

The radius and ulna, especially on the left, show striking changes (Fig. 6), fitting well the description of these bones in "hereditary deforming chondrodysplasia" (5). The metaphyseal ends are widened; the cortex is thin; the medullary spaces are wide, irregular, and translucent. The epiphyseal end of the left ulna has failed to develop properly, and the bones are bent and shortened. Geschickter and Copeland (1, *b*) refer to a non-hereditary type of chondrodysplasia with multiple chondromata of the hands, into which group this case might fall.

In the pelvic bones the epiphysis of the right ilium is not closed, and the pubic bones are rarefied, with thinning of the cortex.

The upper femurs show areas of rarefaction especially in the region of the lesser trochanter, and on the left the cortex is disrupted. The lower third of each femur and the upper tibiae and fibulae show diminished bone density with longitudinal striae of translucency surrounded by lines of increased density (Fig. 7). Such a finding is frequently seen in Ollier's disease, which may be simply a variety of chondrodysplasia, as suggested by Keith.

The bones of the feet show the same abnormalities radiologically as do the hands, but to a lesser degree.

No bony abnormalities are found in the skull, spine, or ribs.

DISCUSSION

Several different theories have been advanced to explain the histogenesis of chondromata. Cartilaginous fetal rests have been suggested by Muller as a possible etiological factor. Geschickter and Copeland (1, *c*) believe that these tumors represent supernumerary joint cartilages and indicate failure of mucoid regression of aberrant strands of precartilaginous tissue. Hume (6) regards chondromata as the result of an abnormal stimulus affecting the center of the growth disk and interfering with the process of ossification. Rickets as a possible factor in the formation of cartilaginous tumors is suggested by the work of McMaster (7).

As has been mentioned, the roentgenogram of the left radius and ulna strongly suggests the condition known as "hereditary deforming chondrodysplasia" (Fig. 6). There is, however, no history of similar skeletal involvement in the parents or brothers and sisters of the patient, although roentgen studies were not made. In addition, no exostoses, usually seen in this condition, are visible on x-ray study. Keith (8) believes the important factor to be a retardation or an arrest of the "modeling process" as a result of limitation of periosteal extension and irregular grouping and division of cartilaginous cells. Geschickter and Copeland feel that the essential abnormality lies in the periosteum, which lags behind its normal rate of differentiation.

Fig. 5. Distortion of the bony architecture of the upper right humerus. Notice the disrupted cortex.

Ollier's disease, presumably caused by a disturbance of the blood vessels or their innervation, is manifest by exostoses or multiple enchondromata or both, along with characteristic striae of translucency surrounded by lines of increased density in some of the bones. This patient shows the chondromata and striae (Figs. 3 and 7) but lacks any clinical evidence of blood vessel disturbance.

As Roberts pointed out (5), "there is obviously a close relationship between chondrodysplasia, multiple enchondromata, and Ollier's disease: our knowledge

Fig. 6. The widening of the metaphyseal ends of the left radius and ulna with thin cortex and expanded medulla the failure of normal epiphyseal development of the ulna, and the bent bones fit the radiographic picture of hereditary deforming chondrodysplasia.

Fig. 7. Longitudinal striae of translucency surrounded by lines of increased density, such as are frequently seen in Ollier's disease.

of the cause of the process involved is, however, still vague." The case reported here appears to bear out his point of view.

Inasmuch as these lesions presumably have been present for nineteen years, and the boy is living a normal and useful life and is symptom-free, a biopsy does not seem justified. This is unfortunate from a scientific point of view as we have here a veritable museum of bone pathology, and only through a biopsy can the exact nature of the lesions be determined.

The possibility of eventual malignant degeneration in some of the lesions deserves serious consideration (9). The patient has been advised that with the onset of any pain or change in size of any of the nodules, he should report at once. In addition, he will be checked both clinically and radiologically from time to time.

SUMMARY

1. A case of multiple skeletal lesions in a youth of 21 is presented, including the roentgen findings.

2. The lesions consist in multiple enchondromata involving the hands, feet, some of the long bones, scapulae, and pelvis. Roentgenograms of the radius and ulna resemble "hereditary deforming chondrodysplasia," and those of the femur and tibia Ollier's disease.

3. A brief review of some of the theories on the etiology of these conditions is given.

NOTE: The photographs reproduced here were made by the U. S. Signal Corps. Most of the roentgenograms were taken by Cpl. A H. Goldberg, Medical Detachment.

Kansas City Quartermaster Depot
Kansas City, Mo.

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Roentgenographic Demonstration of Concretions in the Submandibular Glandular Duct by Use of Intraoral Films[1]

GEORGE D. MONARDO, R.T.[2]

BECAUSE CONCRETIONS in the submandibular glandular duct are difficult of demonstration by the ordinary technics, the diagnosis may not always be made correctly. The postero-anterior projection usually employed may show the stone, but more often it does not and therefore is frequently of little or no diagnostic value. In the lateral view of the mandible the right and left portions are superimposed, and the stone may be demonstrated only if it lies below the bony structure. A lateral view of the mandible on the involved side may show the concretion. A stone in the sublingual area is shown best in the roentgenograph of the body of the mandible. Even in such a view, the shadow of the stone may be superimposed on that of the body of the mandible and, if the density be the same as that of the bone, or less, may fail to be interpreted as a positive finding (Fig. 1). This is also true of submandibular glandular duct stones, which occasionally have been demonstrated in roentgenographs of the condyle and angle of the mandible (Fig. 2).

The best method of demonstrating a concretion in the proximal portion of Wharton's duct and in the sublingual area is by intraoral occlusal films, 2 1/4 by 3 inches, in the infero-superior or submento-frontal position. These projections are usually taken with the patient in a dental chair, with the head well back against a suitable support (Fig. 3). An occlusal film is placed between the jaws, well back and toward the side being examined, so as to include the whole of the gland. It is held in place by the teeth, with the central ray at right angles to the film. This demonstrates a concretion in the sublingual area very well but does not always

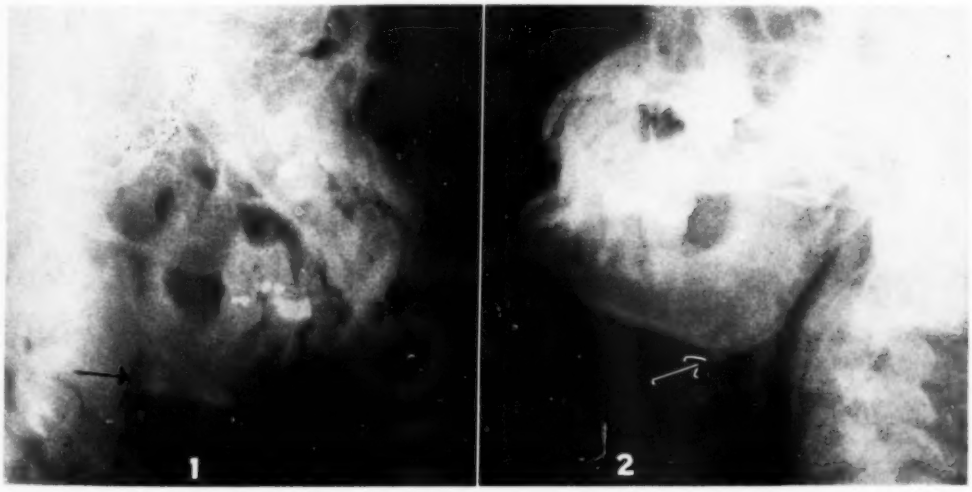


Fig. 1. Shadow of stone imposed upon the body of the mandible.
Fig. 2. Stone in the submandibular glandular duct, demonstrated in a roentgenograph of the condyle and angle of the mandible.

[1] Accepted for publication in May 1945.
[2] On leave from the Department of Radiology, University of Minnesota, Minneapolis, Minn. On duty with the Armed Forces overseas.

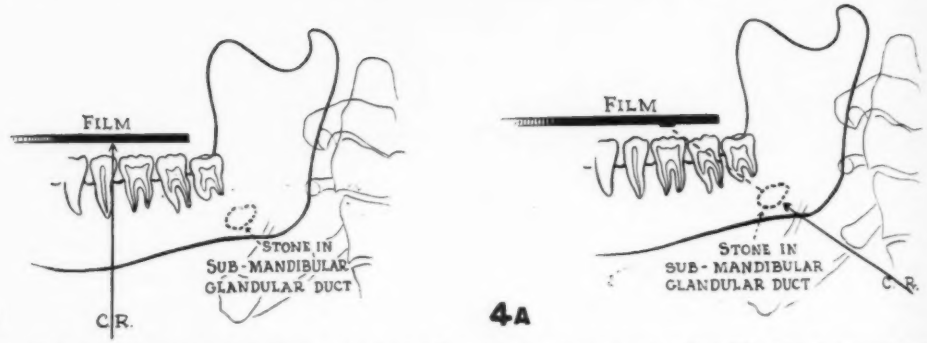
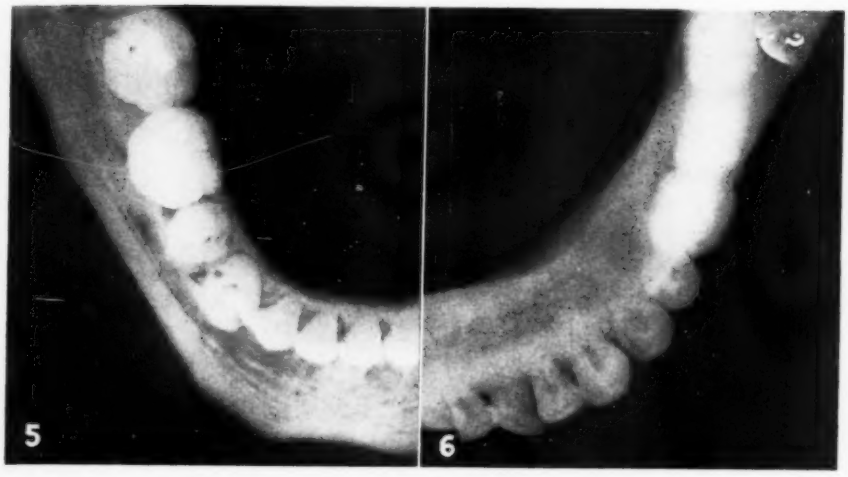


Fig. 3. Technic for demonstration of a stone in the sublingual area; the ray projected at 90° will not demonstrate a stone in the submandibular duct, as shown in 3A.

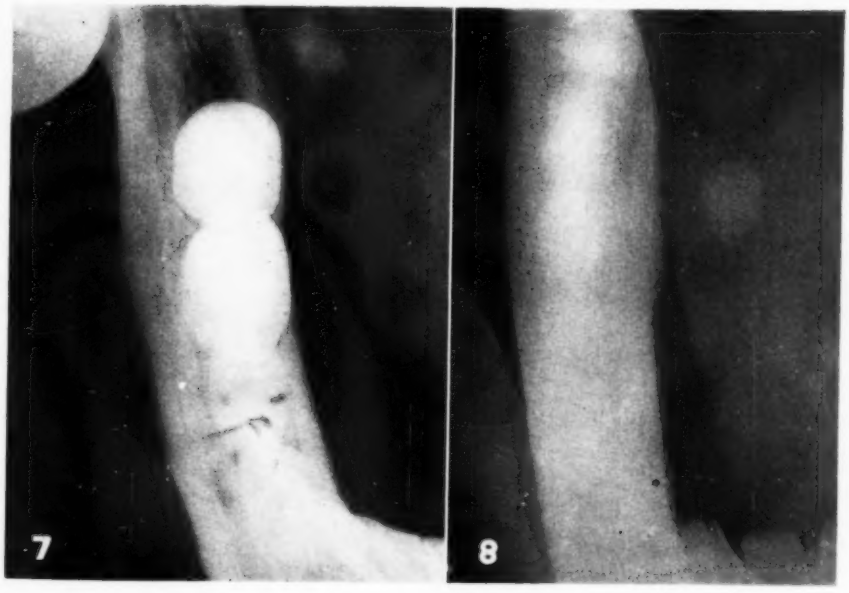
Fig. 4. Position of patient for demonstration of a stone in the submandibular area; the ray is projected at an angle of 45° to the film, as shown in 4A.

demonstrate one in the submandibular region (Figs. 5 and 6).

In the submandibular area a concretion is best shown by the following method. An occlusal film is placed in the patient's mouth as described in the preceding paragraph If the concretion is on the left side, the film is placed to the left. The patient's head, well back on the support, is rotated to the right. The left area of the submandibular glandular duct is next to the tube and is being examined (Fig. 4). The tube is placed as close to the area to be examined as possible, usually at a distance of 25 inches, since in this particular position the patient's shoulder, as a rule,



Figs. 5 and 6. Views made with technic shown in Figure 3.



Figs. 7 and 8. Views made with technic shown in Figure 4.

does not permit contact distance. (Contact distance can be obtained only in the right-angle or 90° projection.) The central ray is projected at an angle of 45° to the film, entering the mandible at its angle, (Fig. 4A). This is done for two reasons. The occlusal film has been placed as far back in the mouth as possible but is not directly above or superior to the concretion, so that a ray projected at 90° does not cast a shadow on the film (Fig. 3A). The second reason is that an angle of 45° is required to project the proper shadow onto the film. The teeth are, of course, distorted. The stone therefore casts a proper shadow upon the film and the correct diagnosis can be made (Figs. 7 and 8).

Technical details are as follows:

I. Sublingual area
Film: Eastman superspeed occlusal dental film
Positioning: Intraoral occlusal, as far back as possible
Central ray: Inferosuperior, perpendicular, 90°
Distance: Contact with dental unit or 14 inches
Ma.: 10 dental unit
Volts: 110
Kilovolts peak: 60–65
Time: 3 seconds

II. Submandibular area
Film: Eastman superspeed occlusal dental film
Positioning: Intraoral occlusal, as far back as possible
Central ray: Inferosuperior at 45° angle to film
Distance: 25 to 30 inches
Ma.: 10 dental unit
Volts: 110
Kilovolts peak: 60–65
Time: 6 to 8 seconds

SUMMARY AND CONCLUSIONS

Two new positions for demonstrating concretions in Wharton's duct and in the submandibular area have been described. Intraoral occlusal dental films are used. It is pointed out that both the 90° projection to the occlusal film and the 45° central ray projection should be employed. The latter projection will superimpose the shadow of the concretion on the film. With these two satisfactory intraoral occlusal roentgenographs, no additional exposures will be required.

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Protection Against X-Rays and Gamma Rays

A Combined Report of the Standardization Committees of the American Roentgen Ray Society and the Radiological Society of North America[1]

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The following report is a compilation of parts, each written by an outstanding authority on his particular subject. Its purpose is to acquaint those who have recently become engaged in the use of x-rays and radium with the actual hazard involved and also to reassure them against imaginary and mythical dangers often associated in popular story with this potent and yet invisible agency.

The penetrating radiations gained a bad reputation because of the fact that the early workers invariably received injuries. Some of them died, and a few are still alive with disfiguring lesions on their hands or elsewhere on their bodies. These injuries were the price they paid for being scientific pioneers. Today, with the accumulated experience of many workers over a period of half a century, the facts concerning the penetrating radiations are so well known that, if the protective measures for their proper use are followed, there is no reason why anyone should receive any injury whatever.

With the expanded use of the penetrating radiations in industry, however, we face two dangers rather than one. First is the actual chance that, where radiation is improperly used, someone will receive a real injury. Second is the mental hazard of those who are in reality perfectly safe but, being misled by legend, may believe themselves to be in danger.

The papers which follow are the result of a combined effort by the American Roentgen Ray Society and the Radiological Society of North America, which societies include all of the trained radiologists and radiologic physicists in the United States and Canada. This paper should serve to inform and to reassure those interested.

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Chairman, Standardization Committee, The Radiological Society of North America.

The Tolerance Dose or Tolerance Intensity

EDITH H. QUIMBY, D.Sc.

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In view of the serious damage which may result from too much exposure to radiation, it becomes extremely important to determine the amount which can be tolerated without producing any undesirable effects. The first impulse might be to say that *all* irradiation should be avoided, and then no reaction could be produced, no matter how low its threshold. Besides the impracticability of this from the point of view of the construction of protective barriers, it is actually impossible because of the nature of the world around us.

The entire earth and all its inhabitants are continually bathed in ionizing radiations of low intensity. Some of these, *cosmic rays*, come from outside the earth's atmosphere. Some, *earth radiation*, come from our terrestrial surroundings. The earth's crust and all natural waters contain measurable amounts of radioactive matter; in general the concentration does not vary

[1] According to the decision of the two Societies, this report will be published in both medical and industrial journals. It has appeared in Industrial Radiography **4:** 35–43, Dec. 6, 1945.

greatly from one locality to another, except in the neighborhood of large deposits of uranium ore. It has been estimated that there is considerably more than 1 gram of radium per square kilometer of the earth's surface and, of course, the gamma radiation from this material is everywhere present. Furthermore, every individual ingests and inhales radioactive matter in food, drink, and air, so it is estimated that a person, by the time he reaches middle age, has approximately 0.015 microgram of radium fixed in his body. The alpha and beta rays from this bombard cells which otherwise would not be reached by these non-penetrating radiations.

It is evident, therefore, that it is impossible to avoid some irradiation and that, in fact, all human development has occurred in the face of such exposure. It may be that a certain intensity of irradiation is now essential to human well-being. It has even been suggested that it has played a part in human (and other) evolution, in view of the genetic changes known to have been induced by ionizing rays.

Be that as it may, the total of these unavoidable irradiations, to the extent of approximately 0.001 r per day, is certainly tolerated continuously by human beings. The question is, how much greater intensity can likewise be tolerated in irradiation of the entire individual. Further, it is important to decide whether this "tolerance intensity" can be increased if the radiation is applied to only a small part of the body, such as the hands of a radium worker.

In animal experiments it is possible to administer progressively higher doses of radiation, protracted or concentrated in various ways, and find the levels at which different types of damage occur. It is impossible, however, to transfer these data to human beings, since the radioresistance of different species varies enormously. Accordingly, the only practicable procedure is to investigate cases where individuals have been exposed to determinable intensities of radiation over long periods, without any evident effects. This is not easy to do, and any conclusions must necessarily be based on certain assumptions as to working hours and working habits over several years. During the period from 1925 to 1932, however, several such investigations were published, each one based on a very limited number of individuals. These articles had been published before the measurement of radiation in terms of roentgens had become generally feasible, and the recommendations were made in terms of a fraction of an "erythema dose" per month. A summary of these reports leads to an average figure of 0.01 erythema dose per month as a safe limit. Accepting the figure of 600 r as an erythema dose for moderately hard x-rays, and a working month of 24 days, one arrives at 0.25 r per day as the safe dose.

The figure of 0.2 r per day has been rather widely accepted as the intensity of x- or gamma radiation which can be tolerated continuously. However, in view of the facts that this result was obtained with moderately low-voltage x-rays and that the same intensity of the more penetrating radiations obtained with higher voltages or with radioactive materials would deliver considerably greater doses to deep-seated organs, the American Advisory Committee on X-Ray and Radium Protection has felt it desirable to reduce this to 0.1 r per day. This is to be interpreted as 0.1 r during any 24-hour period. It does not follow that 0.7 r at any one time during a week, or 3 r at any one time during a month is permissible.

This intensity of irradiation, over long periods, will produce no detectable effect in the individual. No blood or tissue change, or any other reaction, was observed in any of the persons whose records contribute to the accepted figure. The accumulated dose is far below that necessary to produce blood changes, sterility, or any other of the non-genetic effects described in this report.

With regard to genetic injury, it is not possible to be equally dogmatic. The subject is discussed in another section of this report. In the light of available in-

formation on genetic damage, it appears that, while no positive statement can be made regarding the improbability of genetic injury from any exposure of 0.1 r per day, the chance that it will occur to any significant extent seems fairly remote.

All of the foregoing has applied to irradiation of the entire individual. It is well known that when only a small portion of the body is exposed, considerably higher doses can be tolerated. Local exposure is usually more difficult to determine than general. There is never any excuse for local exposure with x-rays; all parts of the body can be protected to the full tolerance limit. However, it may be difficult or impossible to avoid overexposure in the handling of radioactive substances, either natural or artificial, where the manipulation of small sources must be carried out. For a person learning a new technic, the exposure is almost inevitably greater than for the skilled operator, and this must be taken into account in determining procedures. There are few or no direct data on intensities which may be tolerated on the fingers, for instance, and indeed there appear to be considerable individual variations according to the quality of the skin and the care which is taken of the hands. For the present, it is recommended that the rate of local exposure to fingers or hands shall not be more than ten times the tolerance rate for general exposure and shall be kept lower if possible. No other part of the body should be subjected to more than the tolerance dose for the entire body.

Radiation Injury

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The effects of the radiations from x-ray tubes (x-rays) and from radium (gamma rays and beta rays) on the human body are quite well known, because these rays have been used by physicians for nearly fifty years. Since the effects of the three are similar in broad outlines, we will use the term "radiation" in this section for them all, in order to avoid repetition.

At the outset it should be emphasized that there are no "mysterious" effects. While these radiations may seem mysterious to those who have not used them, their behavior is governed by definite physical laws which are known to those who have made a study of them. The radiations being considered here may have very harmful effects; yet so may sunlight, electricity, and a great many other common things if they are not properly used. When controlled, they can perform useful service to man without injury; but, as with other things, when improperly used they may injure people, and the injuries they cause are known. The injury may be the result of a single severe overexposure or of multiple small overexposures of local parts of the body, as the hands, or of the whole body.

Acute Local Overexposure: If a person exposes any part of the skin surface to a large quantity of these radiations, he gets what is called an "acute" reaction. This reaction resembles a sunburn in some respects. The skin becomes red; it may blister if the dose is large enough, and ulcers may form if the dose is very large. One difference from sunburn is that it takes many days for the reaction to develop. When the exposure is just sufficient to produce a faint reddening of the skin, the color may not appear for a month. If the exposure is very great, the reaction may appear in a few days. Sometimes a faint redness is apparent a few hours after the exposure and then goes away only to return again and get worse several days later. Another difference from sunburn is that these reactions take longer to heal and are more painful. When they heal,

they leave the skin tanned if there has been no blister, or white and dry, and thin, if there has been an ulcer.

Such effects as those just described should never result from any industrial work or medical radiography. They require large amounts of radiation such as physicians use in treating cancer. They can result, in industrial radiography, only from gross carelessness or ignorance of how to control the radiations.

Repeated or Chronic Local Overexposure: When the single exposures are not large enough to cause the reactions described above, they may still cause changes in the skin which are not visible to the eye and not felt by the person. Yet, they are very real. If only one such exposure occurs, it has no significant consequences; but when similar exposures occur day after day or week after week, trouble finally develops. Just how and when these changes occur depends upon the amount and the quality of the radiation to which the part was exposed. If the amount received is just below that required to cause a redness and it is frequently repeated, a reaction will eventually develop that is much like that from a large single dose. If the amount is, say, one hundredth part of that required for an acute reaction and it is repeated every day or two, it may take a year or more for any trouble to appear. The "trouble" will not resemble a sunburn at all. The skin will become tight; its wrinkles and ridges will disappear; it will be dry and shiny and it may be slightly red. Later on, crusts or warts will appear. In a few people these crusts and warts will turn into skin cancer.

Such changes as these are found on the fingers of dentists who habitually hold films in patients' mouths; on the hands of physicians who work under the fluoroscope without proper protection or who hold babies or other patients too frequently while taking radiographs; on the hands of anyone handling inadequately protected radium repeatedly; on men improperly holding metal or other industrial materials while making industrial radiographs.

It must be emphasized that years of continuous exposure may be required for these changes to develop, without warning meanwhile of the impending danger. Many of the pioneers in the medical application of x-rays and radium found that their hands and other parts of their bodies were damaged years after they had started their work. Many physicians who did not understand how to use x-rays were called upon to use them during World War I and, after the war, "trouble" developed.

Such changes *need not* come about. The physicists have instruments to measure these radiations and we now know how much radiation a person can tolerate. If the radiation about any job is measured (as it can be) and if conditions are modified to keep this radiation to a low level (as they can be), no one need be damaged.

Local Irradiation of Hair-Bearing Areas: Hair can be made to fall out by amounts of radiation that are just less than those required to produce an acute or even a moderate reaction of the skin. Hence, massive falling out of hair is an indication of overexposure. If the dose is just enough to make the hair fall out, it will grow in again in a few weeks or months. Repeated exposures of this kind result eventually in the chronic changes described above. Frequently, in such cases, there is another change not seen so often on the hands, namely, the appearance of many irregular red blood vessels just under the skin, so-called, "telangiectasis."

Effects on the Testicles and Ovaries: The effects of repeated exposures of the testicles or ovaries will be described elsewhere. It should be understood, however, that impotence, that is inability to have sexual relations, is not a result of irradiation. After excessive overexposure, as in medical treatment for cancer, the ability to produce children may be lost temporarily or permanently, but not the ability to perform or enjoy the sexual act. This amount of radiation could not possibly be received in an industrial accident without other and more obvious injury accompanying it.

Radiation to the Entire Body or Large Portions of It: We have been discussing largely the effects on local areas of skin. If the entire body is exposed, other changes result. Excessive overexposure of the whole body—to an amount that would cause redness in a local area—will result in death. Smaller doses will cause various changes that can be detected because other parts of the body than the skin are changed.

The *blood* is one of the most important elements of the body that is affected early and by relatively low overexposures. The blood contains red cells and white cells, the white cells being the more easily affected. Doctors can count the blood cells, both white and red, and hence can detect early radiation injury before it becomes serious and can measure the extent of damage done. When speaking of the blood, we include the bone marrow, because it is there that many blood cells are formed. The blood, like the skin, is affected by both large overexposures and by chronic repeated smaller overexposures. Large exposures cause a decrease in the number of all types of cells, but the effect is first seen in the white cells. With repeated low-level overexposures, the white cells are likely to be the only ones to show the effect until very late.

If the overexposure persists for a considerable period, there will develop in a certain number of people a "cancer of the blood" called leukemia. This is rather rare but can be caused in animals by irradiation over prolonged periods. In other people an anemia will develop, due to the fact that the bone marrow cannot produce enough red cells for the blood.

Because of these possibilities, it is necessary for people who are exposed or possibly exposed to radiation to have the blood examined at regular intervals by a qualified physician. If the changes are detected early, a change of occupation can be effected, and recovery from the effects will follow. Especially important is it that the working conditions and the protection of the apparatus be changed so that no one else is overexposed.

There is another group of tissues in the body, known as *lymphatic tissues*, which are easily affected by radiation. Since some of the white blood cells are produced by these tissues, changes in them are picked up by examining the blood. If these tissues are affected too much and too long, they may change into another form of cancer, called lymphoblastoma. Few, if any, people have been known to have this disease as a result of overexposure, but it is common in overexposed animals and is sometimes associated with leukemia.

Overexposure of radium miners to a gas that comes from radium is suspected of causing cancer of the lungs. This disease has not been associated with overexposure to x-rays or to radium as handled in medical or industrial work.

In radium watch dial painters who swallowed radium, and as a result had radium deposited in their bones, *bone* diseases developed as a result of the local irradiation. These were (1) a local weakening of the bone with pain, (2) an infection of the bone (osteomyelitis), and (3) cancer (sarcoma) of the bone. No such changes have been found from radiation coming from the outside to the whole body.

There are some *general symptoms* that develop from irradiation of the whole body or from heavy overexposure of parts of the body. The mildest of these is nausea with loss of appetite. This may come from so many other conditions of work or upset home life that it is difficult to relate it directly to industrial exposure to radiations. The next more severe symptom is vomiting. It takes quite large doses of whole body exposure to produce this in an otherwise healthy individual. In most instances, some other cause than radiation must be sought, unless a heavy exposure is known to have occurred. General weakness and tiredness are not due to overexposure itself but will accompany a chronic anemia from overexposure, as they will accompany anemia (loss of blood cells) from any other cause.

In conclusion, it must be pointed out that all of the above conditions are preventable.

Radiations can be measured by properly qualified physicists. The "safe" dose is known. The dose necessary to cause the above changes is known to a degree. The apparatus for both medical and industrial work can be so protected that the amount of general and local radiation is well below the safe level. Proper medical care can do much to alleviate symptoms but cannot restore a severely damaged individual to normal. Early changes may be picked up by medical examination, but late changes may occur without early signs or symptoms that would be apparent to an untrained person. Prevention of exposure is the keynote for safety.

Genetic Injury

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Exposure of mature sperm or ova to x-rays before fertilization results in abnormalities of development. When such abnormalities reappear in succeeding generations, it is plain that the cytologic changes induced occurred in the hereditary elements. In certain plant and animal forms where special cytologic and breeding tests can be performed, it has been shown that some of the abnormalities can be correlated directly with chromosome aberrations (deletions, inversions, and translocations) and also with gene mutations.

In the fruit fly, *Drosophila*, such developmental abnormalities may be a change in the shape of wings, the number of bristles in a particular region, the number of pigmented eye facets, etc.; in plants, they may be modifications in leaf or petal structure, change in color pattern, and the like. In higher forms, including man, characteristics such as complexion, stature, mental capacity, etc., are known to be hereditary and controlled completely or in part by chromosomes. Experiments have demonstrated that various hereditary patterns in higher forms (rats and mice) can likewise be modified by exposure of mature germ cells to radiation—presumably through alteration of the chromatin material. When such chromosome changes lead to modification of vital organs in development and death results prematurely, they are called "lethal mutations." Actually, chromosome alterations have been observed in lower forms which lead to death before the organisms are old enough to be used in breeding tests but, because of the similarity of the chromosome changes involved, they are presumed to be lethal mutations in the same sense. All chromosome modifications, which presumably can be shown to be inheritable if breeding tests could be carried out, are regarded as genetic.

Irradiation of sea urchin sperm or ova before fertilization often leads to multipolar cleavage at the time of the first mitotic division of the zygote. After such changes, several subsequent divisions may occur in the cell progeny, but usually death of the new organism occurs very soon. In other embryos of the same samples, abnormalities do not show until later in development. Depending on which cell group is involved, the abnormality may result in death or various degrees of monster formation. In *Drosophila*, irradiation of mature sperm in the male and of mature ova in the female leads to similar changes after fertilization. Treatment of frog gametes likewise leads to the most bizarre development. In some embryos, excessive proliferation takes place with almost no differentiation; in others, differentiation occurs but it is extremely abnormal. In mammals, exposure of male or female mice or rats before conception has also led to abnormalities. When the developmental changes take place early in the higher forms and are of the lethal variety, usually resorption occurs and the

only effect seen is smaller litters. When changes occur late, abnormalities may be seen in the offspring. In these types of injury, it is safe to presume that many—perhaps indeed a large portion—of the changes induced resulted from chromosome modifications.

From our general understanding of heredity it is known that some mutations are inherited as dominants and others as recessives. Thus, recessive abnormalities may be masked by the dominant and not be revealed for many generations, or at least until two recessive mutant genes come together in the same offspring. Through an accumulation of such recessive mutant genes in the population, it is conceivable that irradiation changes may become more prominently revealed in future generations. Whether gene and chromosome changes and developmental abnormalities are produced in human beings the same as in other forms is as yet not satisfactorily demonstrated. However, because of the universal similarity of the hereditary mechanism in organisms generally, and the similarity of the action of radiation in the cases studied, it seems likely that changes are being produced in exposed human beings the same as in other forms.

The chief problem, then, is one of determining whether the present permissible exposure level (0.1 r per day) contributes unfavorably to the genetic well-being of the human race.

The Question of Threshold: The concept of tolerance, as usually applied, implies that there are levels of irradiation exposure below which injury will not be produced. For effects such as skin erythema, sterility, and lowered leukocyte level, significant amounts of radiation can be administered before changes will begin to be manifested. With regard to this type of change, one can speak with justification of threshold doses and think in terms of safe levels.

For changes such as the production of mutations (in *Drosophila* and various plant forms) and the killing of microorganisms (bacteria, viruses) there appear to be no threshold levels of dose as determined by actual experiment. The frequency of occurrence starts from zero dosage, rising rapidly at first but diminishing as the amount of affected material is reduced. These effects are all-or-none in character and appear to result from single atomic or molecular changes induced by radiation. In such instances one cannot speak of threshold doses or tolerance levels, as they do not exist. As soon as the dosage exceeds zero, there are certain chances that any particular cell will be affected. The greater the dose, the greater the frequency of cell change.

Mutation Rates: It has been shown that for a particular mutation in *Drosophila*, the normal spontaneous rate of occurrence is practically doubled by doses in the neighborhood of 30 r. Since the normal spontaneous rate for this mutation is approximately 1 in 1,000 (1 out of every 1,000 cells showing the effect), this means that the frequency, instead of being 1 in 1,000 as normally, is raised to 2 in 1,000 by doses of 30 r (approximately the exposure for one year at 0.1 r per day).

Assuming for the moment that the action of radiation in human beings might be the same as in *Drosophila*, the thought of having the chances of abnormal offspring increased from 1 in 1,000 to 2 in 1,000 does not appear to be so great a hazard and probably would not deter prospective parents in accepting exposure when occupationally necessary. The figures just given, however, pertain to only one kind of mutation (in *Drosophila*), when actually there are many kinds, any or all of which may have far-reaching biologic consequences. The possibility of producing some kind of mutation, then, even with small radiation doses, appears considerably greater.

Irradiation-Induced Mutations in Human Beings: With the possibility of irradiation-induced mutations appearing so likely, why are abnormalities not seen more often in the offspring of individuals exposed to radiation? Two possible explanations will be offered here and others will become apparent later. First, irradiation-induced

mutations result in changes which are often identical with changes which arise spontaneously, making the detection of abnormalities resulting from exposure to radiation dependent upon statistical evaluations. Some statistical studies have been made but, although a small amount of positive evidence has been obtained, the data are so limited they have little meaning. Second, many mutations are recessive in character and, since the possibility of two similar mutant genes coming together in the same individual is very remote at first, the process of production of such genes must be in operation a long time before recessive characters can be manifested in appreciable numbers.

Evolutionary Aspects: In a system as delicately balanced as the living cell, it is obvious that radiant energy for the most part would have disorganizing or deleterious effects. Since such deleterious effects may become fastened on the germ line in the form of mutations, they may contribute to a growing racial weakness. This possibility has caused some to express concern over the fate of future generations and urge that prospective parents should avoid exposure to ionizing radiations completely. As we now know, however, this is impossible, as all living things through succeeding generations have been exposed to earth and cosmic radiations at the rate of approximately 0.001 r per 24-hour day. It is a fair question then to ask whether the trend in the past has been toward racial weakness and whether stepping up the exposure by a factor of 100 (*i.e.*, to 0.1 r per day) would be unfavorable racially.

There seems little question but that high-energy radiation in any amount will contribute to a greater frequency of abnormalities in first-generation offspring. On this point most investigators agree. Attitudes differ, however, concerning the possibility of mounting racial weakness. While evidence is available from *Drosophila* showing that the number of irradiation-induced mutations is accumulative in succeeding generations, it would appear that through the forces of nature (natural selection and survival of the fittest) the unfavorable features are not retained. Indeed, there is available a small amount of evidence, also from *Drosophila*, indicating that certain types of injured germ cells are unable to complete the process of maturation and are thus prevented from passing on the abnormalities. Just how completely irradiation changes are removed from the germ line by natural forces has yet to be demonstrated.

Implications: It is plain from the brief dissertation presented here that the attitudes taken at this time toward irradiation of the germ line may have far-reaching biologic consequences. It is plain, also, that some exposure of the germ line will occur despite all that man may do to prevent it. Whether 0.1 r per day will add appreciably to the hazards of life is as yet not known. However, in view of the fact that exposed sperm or ova of many species are known to pass abnormalities to offspring, it would seem not ill-advised to assume that exposure of the germ line should be kept at a low level. Only further experience will make it clear whether we wish to tolerate the injury caused by 0.1 r per day.

The suggestions arising from the present considerations have still further significance. As yet the process of lethal mutations has not been eliminated as the mechanism whereby the cellular elements (lymphoid and myeloid cells and germinal epithelium of the skin and gonads, etc.) of higher forms are destroyed. It is not improbable that cells such as lymphocytes are killed by the single-hit mechanism, the same as bacteria or viruses, and that the present so-called "tolerance" exposures represent the regenerative capacity of the cellular reserve of a particular tissue. In such a case, injury to the host organism would be seen only when the rate of destruction of cells exceeds the rate of production or the ability of the organism to compensate fully.

At this time it is important to keep in mind:

1. That for a certain type of cell killing there may be no threshold level of exposure but that, for certain types of injury in the mammalian organism, subthreshold or subliminal exposures may exist.
2. That subliminal effects, present over a period of years, may be important factors in later life, especially in long-lived forms.
3. That in last analysis it may be more correct to speak in terms of "tolerance injury," that is, the amount of injury an organism can tolerate without complication, rather than "tolerance dose."

Human Factors

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One of the commonest causes of radiation injuries to the hands of a physician is the manipulation of fractures during fluoroscopy. The chance of such injury is minimized where the orthopedist is working in co-operation with a radiologist who knows the dangers and insists on discontinuation before the tolerance dose is reached. Many orthopedists and general practitioners, however, own or have access to a fluoroscope and use it daily without regard for damage until too late. Many of the older fluoroscopes, because the tube is closer to the table top than in the newer instruments, put out an excessive amount of radiation. The aluminum filter so necessary to stop the less penetrating rays, which are of no value in the production of the visual image but have strong biological effect, is in many cases omitted. Having a machine tested by one competent to do this work will greatly reduce the hazard. Finally, there is no need for the orthopedist to expose his hands, because he can easily learn to do the manipulations, then look, with his hands out of the field.

One feature which is grossly neglected by most inexperienced fluoroscopists is proper eye accommodation. Most of them feel that their time is too valuable to spend in subdued light and that the wearing of accommodation goggles is too much trouble. Any person who feels that he can see the fluoroscopic image without long eye rest under very subdued light of the correct quality is simply fooling himself. Unfortunately, the inexperienced fluoroscopist, in attempting to see the screen as soon as he goes into the fluoroscopic room and finding the image of low visibility, will increase the milliamperage on the tube instead of waiting for his eyes to accommodate. Regardless of all that has been said and can be said, this necessity is still a matter of common disbelief among those who have not had extensive training with the fluoroscope.

The removal of foreign bodies under fluoroscopy is extremely hazardous. Needless to say, the above-mentioned precautions about having a reasonably safe machine should be observed. Frequently the operator becomes so absorbed in his task that he loses all idea of time until a desperately heavy dose has been given to his fingers or to the patient. Here again, as in the previously mentioned case, proper eye accommodation is vitally important.

If all of the above work is done with a correctly designed fluoroscope, the chances of injury are minimized. Unfortunately, much of this work is done not with such equipment but with a portable machine which has no spacing arrangement of any kind to prevent the skin of the patient from being placed within a very few inches of the tube. Of course, in this case, an enormously greater dose is given to the skin than in the instance where a tube on the fluoroscope is 14 to 20 inches below or behind the table top. It is a common

human failing to regard the small portable machine as so innocent looking that it is incapable of doing much damage.

The fluoroscope or, as far as that goes, any x-ray machine, should never be used as a toy or as a means of entertainment. There are many cases on record where inexperienced operators in demonstrating fluoroscopic images to their friends or to interested patients have caused serious damage.

A lead-rubber apron should, at all times, be worn by one who operates the fluoroscope and by those who are in continuous attendance close to the machine. A person who does this work should make it a definite rule never to place his hands in the beam unless he is wearing lead-rubber gloves. Other protective materials such as lead-glass goggles or head masks are unnecessary and, in most cases, such a nuisance that they prevent good work being done. The present type of fluoroscope does not, as a rule, need any added protection such as a lead frame around the fluoroscopic screen, although some careful operators prefer to have them.

Much discussion has taken place about the practicability of the manufacturers placing a label on their machines as to the safe limits of operation, but one who is familiar with the subject realizes full well that no label could be written which would cover all the circumstances, and that there is no x-ray machine which is biologically safe if improperly used.

The manufacturers have done an excellent job in making modern equipment electrically safe, and the best possible job in making it safe from the point of view of radiation, but no one yet has built a machine which is fool-proof. In this work, as in any other work, there is no substitute for common sense.

X-Ray Protection in Industrial Fluoroscopy

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X-ray protection in industrial fluoroscopy involves problems somewhat different from those of protection in radiography. In the first place, for an object which is thin enough for fluoroscopy, higher voltages are generally employed on a fluoroscope than for a film. This is because the fluoroscope does not have the property of integrating or accumulating the x-ray effect as does the film. The screen fluoresces according to the instantaneous energy which it receives and, therefore, a higher instantaneous energy is required. From the point of view of load on the x-ray tube, the screen brightness is most efficiently increased by raising the voltage applied to the tube. This tube voltage has been raised to 220 kv. in some industrial fluoroscopes. Tubes which can be operated at much higher voltage than this are available, but to use them for fluoroscopy introduces a protection problem out of proportion to the gain in visibility obtained. For this reason, the practical limit in tube voltage in industrial fluoroscopy is about 250 kv., while in radiography 2,000 kv. may be employed. At a given kilovoltage the protection problem in fluoroscopy is more formidable than in radiography because the x-ray tube is operating for a much longer total period of time and, even though it may be at a lower tube current, the total amount of x-rays generated is usually much greater. Furthermore, the fluoroscopist is apt to be much closer to the tube than the radiographer.

The hazards of industrial fluoroscopy may be considered from the point of view of (*a*) the fluoroscope operator and (*b*) the other people who work near the fluoroscope. The x-ray protective material must be applied so as to absorb sufficiently (*a*) the direct x-ray beam, and (*b*) the scattered or secondary x-rays.

The direct x-ray beam should be effec-

tively blocked off by using a sufficient thickness of absorbing material, preferably lead, around the x-ray tube itself and in the fluoroscope housing. That part of the direct x-ray beam striking the fluoroscopic screen has to be absorbed by a sufficient thickness of lead-glass. The thickness of lead, and lead-equivalent thickness of lead-glass, to protect from the direct x-ray beam at various kilovoltages and tube currents will be found elsewhere in this report. It is essential in providing for protection against the direct x-ray beam that no leaks occur in the construction of the unit. Methods of testing for leaks will be described below.

It cannot be too strongly stressed that the hands of the fluoroscope operator must never be allowed to enter the direct x-ray beam. This might be done in adjusting the position of a specimen while its fluoroscopic image is being observed. This is usually prevented by having a safety switch on the fluoroscopic cabinet which automatically turns off the x-ray when the cover is opened. Such a safety device should be placed on every industrial fluoroscope where the operator could possibly get the hands in the direct x-ray beam. The lead-glass over the fluoroscopic screen protects the operator's face from the direct x-ray beam. Care should be exercised that the lead-glass covers the beam under all possible circumstances. If any adjustments of the x-ray tube are made, or if a new tube is installed, this should be carefully checked again.

Scattered x-rays are less penetrating than the direct beam but they have to be separately considered because they are emitted in all directions wherever x-rays penetrate matter. In industrial fluoroscopy, scattering comes principally from the castings or specimens being examined. This is an added problem because sometimes one end of a long casting which is being examined may project from the fluoroscope housing, thus possibly allowing the escape of scattered x-rays. Should the operator or an assistant hold or manipulate the casting during fluoroscopy, there is the possibility of excessive exposure of the hands and other parts of the body to scattered radiation. Fluoroscope housings or enclosures may also be open in some types of systems where the specimens are brought to the fluoroscope on a conveyor belt. In this case, scattered x-rays can escape through the entrance and exit openings. Baffles should be provided to intercept the scattered rays or care should be taken to see that no individual is allowed to be in the zone of scattering for an appreciable period of time. Such imperfections can usually be overcome by proper layout of the conveyor and fluoroscope. Conveyor systems in which the specimens are brought vertically up to the fluoroscope, then horizontally across it for the examination, and finally leave it by moving vertically down can be more easily and more thoroughly shielded from scattered radiation. In nearly all cases of industrial fluoroscopy it has been found possible to do a very thorough job of installing x-ray protection so that there can be no possible serious injury to the fluoroscope operators or surrounding personnel. With proper installations and good methods of testing for leaks, an industrial organization will be protected in case of any future law suits.

METHODS OF TESTING X-RAY PROTECTION OF FLUOROSCOPES

The Geiger-Müller counter offers an extremely rapid, sensitive, and convenient method of checking the x-ray protection of any fluoroscope. The instrument can be made in a handy form to carry around the fluoroscope or to test any suspected location. The counter is usually operated from a 110-volt A.C. line and is furnished with head phones giving an audible signal when the sensitive counter tube is traversed by x-rays (or gamma rays of radium). An ordinary-sized counter tube may have a sensitive volume whose cross section is 1 cm. by 3 cm. This is sufficiently sensitive for this type of work, since it will give a background count (from cosmic radiation exclusive of possible

radioactive contamination in building materials or of radium being used in nearby locations) of about 8 counts per minute. It is thus capable of detecting stray radiation within the intensity range of cosmic radiation. Such a highly sensitive instrument is not a drawback, because it is possible in practice to build a closed industrial fluoroscope with sufficient x-ray protective material so that the counting tube may be placed in any position around it and the clicks in the head phones can easily be counted by ear.

With a Geiger-Müller counter of the size mentioned above, working on the plateau of its voltage curve (that is in the most sensitive part of its stable range), giving clicks at a rate which can readily be counted, the tube will be in an x-ray field having an intensity which is many times below that of the tolerance exposure intensity. Therefore, if a fluoroscope is examined while it is in operation with such an instrument and nowhere are clicks heard more rapid than can be counted, the x-ray protection can be confidently said to be sufficient. It is, of course, necessary to know that the counter is operating correctly and that every location in which a person may be has been thoroughly covered. In using the Geiger-Müller counter equipment, the fluoroscope is examined while it is in routine operation. By moving the sensitive tube around the housing, while listening with the ear phones, one may detect any x-ray leak immediately as a sudden burst of clicks. By moving the tube around, the exact location of the leak (such as a nail hole or crack) can be located. The adequacy of the lead-glass covering the fluoroscopic screen may also be tested. When any change is made in the fluoroscope, the x-ray protection should again be checked. The answer can be obtained in a few minutes by this method.

Another method of testing for leaks or scattered radiation from an industrial fluoroscope makes use of x-ray film. The areas to be tested are covered with an x-ray film, which is placed in a light-tight envelope. After the machine has been operated for a few hours, the film is taken to the dark room and developed. If there is an appreciable x-ray leak the film will be blackened over that area. The same principle is employed in testing for x-ray exposure of any member of the personnel. A dental type film is fastened to the wrist or chest. The side marked "tube side" must be facing out and it can be covered with a paper clip to aid in analyzing the film later. The film is worn in this way at all times that the individual is at work. After two days the film is removed and developed. If it is fogged sufficiently so that the shadow of the paper clip is visible, the situation should be further investigated and more x-ray protective material added so as to absorb the radiation leaking out from the fluoroscope.

It is also possible to test for small amounts of stray x-rays with a highly sensitive ionization chamber. Such a chamber with its charging equipment and measuring string electrometer is now on the market (Victoreen "minometer"). The chamber, which is about the size of a fountain pen, is electrically charged to a certain degree, as indicated on the electrometer. It is then worn for a working day in a vest pocket of the person being tested. The chamber is returned and immediately connected to the electrometer, which indicates the degree of discharge from x-ray exposure in terms of roentgens. The chamber may also be placed in suspected positions around the fluoroscope, and x-ray leaks will be indicated by various degrees of discharge as shown by the electrometer.

Another precaution that can be observed in checking an overexposure to x-rays is to take periodic blood counts on all persons who might be exposed to x-rays. By taking these counts at about two-month intervals, a base line can be established for each individual. Then, if a large proportion of the worker's body has been exposed to an excessive amount of x-rays, the damage will be reflected in the blood count, principally by a drop in the white

cell count and a rise in the reticulocyte count. Such counts must be interpreted by a physician familiar with the effects, because even in a normal person the count may vary quite widely from time to time. It is important to realize that a periodic blood check is of value in estimating damage from whole body irradiation. A localized devastating exposure of x-rays could be administered to a hand or foot without appreciably affecting the blood count. Furthermore, by the time the blood count has been affected enough to indicate an excessive x-ray exposure, considerable damage may already have been done to the body.

Materials and Methods of X-Ray Protection

GEORGE SINGER
Acting Chief, Radiation Section, National Bureau of Standards, Washington, D. C.
and
GEORGE C. LAURENCE, Ph.D.
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The object in planning x-ray protection for any installation is to reduce the x-ray intensity at all positions where personnel will be stationed to a value such that no one will receive more than 0.1 r during any 24-hour period. No hard and fast rules need be laid down for accomplishing this; the methods to be used are best left to the ingenuity of those making the plans. Almost any space can be made safe against x-rays by the use of lead or concrete walls of sufficient thickness, though in practice such an installation would probably be considered prohibitively expensive, especially when protection against very penetrating radiation is required. The alternative is to consider other methods of protection to be used in addition to radiation barriers. In the interest of economy, full consideration should therefore be given to all three of the following factors: (1) distance from barrier to x-ray source; (2) direction of x-ray beam; (3) radiation barriers.

Distance from Barrier to X-Ray Source: The intensity of any beam of x-rays falls off inversely as the square of the distance from the x-ray tube target. This holds true for all x-radiation regardless of its penetrating power. For example, a twofold increase in distance from the tube target results in a fourfold decrease in the x-ray intensity; a tenfold increase in distance reduces the intensity to 1.0 per cent of its initial value. By making the distance from the x-ray source to all operating stations as great as possible, a saving can be effected in the cost of lead sheet, concrete, or lead-glass. Such savings increase rapidly as the penetrating power of the radiation goes up, for then progressively thicker barriers are required to reduce a given beam to, let us say, 1.0 per cent of its initial value. Regardless of what the radiation quality may be, however, the same percentage reduction can be brought about by increasing the distance tenfold.

For reasons of economy, first consideration should, therefore, be given to the matter of distance between the x-ray source and all occupied spaces in the immediate vicinity. The x-ray room should be as far removed as conditions will permit from all offices, laboratories, and shops where workers remain throughout the working day. Where occupied rooms must be near the x-ray space, it is good practice to place them on opposite sides of a corridor. Inside the x-ray room, the tube should be placed as far away as possible from all operators, consideration being given to the use for which the radiation is intended and to the space available for the purpose. In neither medical nor industrial x-ray rooms can full advantage be taken of the saving possible through increasing the distance from the x-ray source; it may be necessary to watch a patient during treatment or to palpate a patient during a fluoroscopic examination;

in industrial radiography and fluoroscopy within protected cabinets, the presence of nearby operators may be essential. In any case, all persons concerned with the operation of an x-ray installation should understand clearly that the first defense against any radiation hazard is distance. The safe thing to do is to "stay away."

common use, are designed to reduce the radiation intensity transmitted by any part of the housing—other than the exit port—to about 1.0 per cent of that of the useful beam. It must not be assumed that this is always so; many tube casings have insufficient protection, especially at the cathode end. Nevertheless, by directing the exit port away from all occupied spaces nearby, full use is made of such protection as has been built into the tube housing by the manufacturer. The problem is thereby simplified; protection remains to be provided only against the direct radiation not absorbed by the tube casing and the radiation scattered out of the main beam by the air and by irradiated

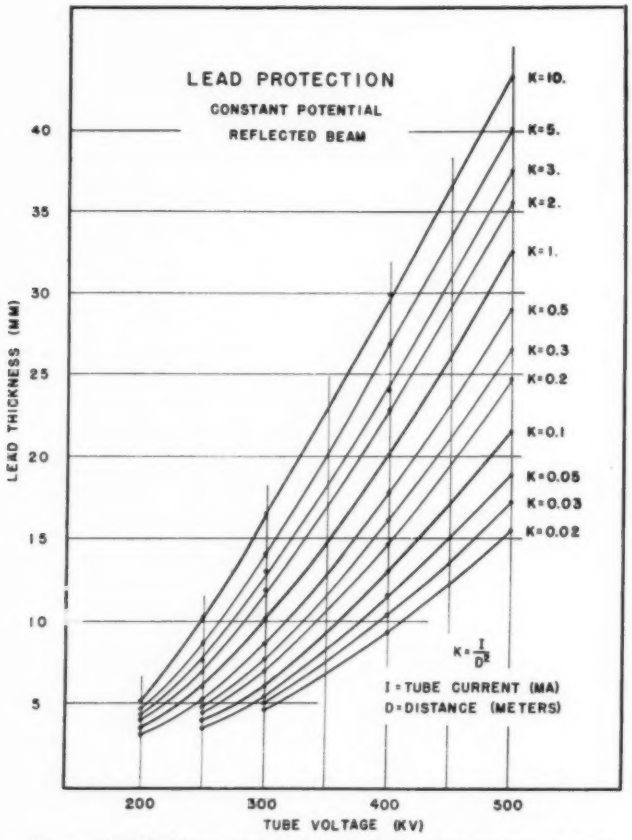

Fig. 1. Lead thickness required for protection against narrow x-ray beams generated by voltages between 200 and 500 kv. for various distances between the tube target and operator.

Direction of X-Ray Beam: The second consideration in planning x-ray protection should be the direction of the x-ray beam. Wherever possible, the main beam should be directed away from occupied areas, preferably toward the ground or an outside wall remote from adjacent buildings or yards where men may be at work. So-called "ray-proof" tube housings, now in

objects. The thickness of lead provided by the tube housing may be subtracted from the total required to afford adequate protection, but only in those directions in which the shielding action of the case is known to be effective and for which sufficient protection against scattered radiation has been provided.

Radiation Barriers: When full advantage has been taken of both distance and tube orientation, it will usually be found that the radiation intensity is still excessive at the control station and in adjacent rooms. Thought must then be given to protective walls or screens. For x-rays generated by voltages under 250 kv., lead

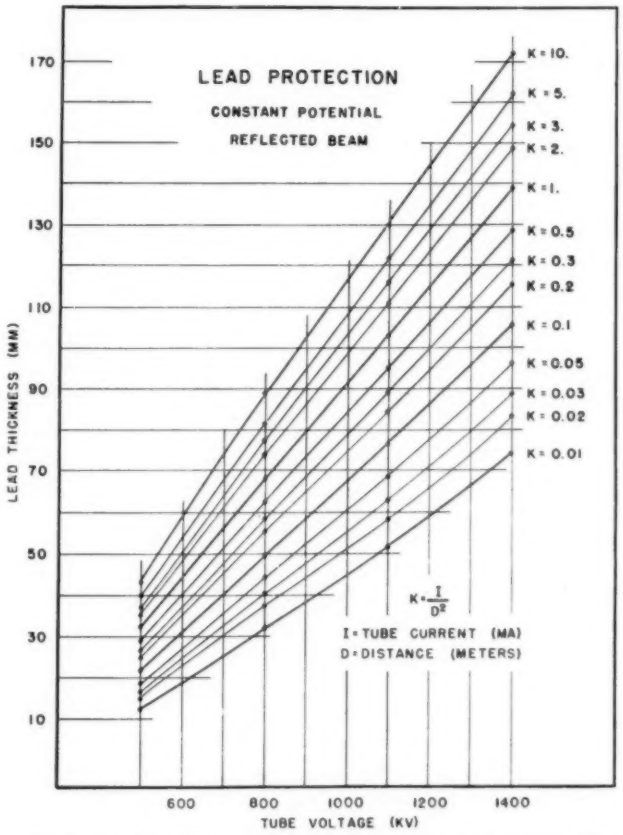

Fig. 2. Lead thickness required for protection against narrow x-ray beams generated by voltages between 500 and 1,400 kv. for various distances between the tube target and operator.

For many applications, it is essential that the x-ray tube head be left free to rotate into any desired position; then one has no choice but to provide protection against the full intensity of the useful beam by increasing the distance to all nearby occupied spaces, by interposing protective barriers of adequate thickness, or by a combination of both methods.

sheet is generally used for this purpose; for more penetrating radiation, concrete is most often chosen. The use of lead sheet in combination with concrete is becoming more common and has much to recommend it. The type of barrier selected is determined by relative cost and convenience.

Two classes of protective barriers should

be distinguished: (1) barriers against direct radiation—from the tube port, from leaks in the tube housing, and from radiation not absorbed by the tube housing; (2) barriers against scattered radiation—scattered by the patient, walls of the room, or other irradiated objects. The scattered radiation is generally less penetrating and less intense than the direct radiation; less protection is, therefore, needed against it.

From curves given in Figures 1 and 2, it is possible to compute the thickness of the lead barriers necessary for shielding against *direct* x-radiation generated by constant potentials between 200 and 1,400 kv. The data needed for making this computation are: (1) the tube current, (2) tube voltage, and (3) the distance. The computation is made as follows:

A. Find K by dividing the tube current in milliamperes by the square of the distance to the tube target in meters, thus:

$$K = \frac{I}{D^2}$$

where I = tube current in milliamperes and D = distance in meters from target to nearest person.

For example, if the nearest person is 3 meters from a tube passing a current of 3 ma. at 1,000 kv.,

$$K = \frac{3}{(3)^2} = \frac{3}{9} = 0.33$$

B. Select the curve in Figure 1 or 2 having the value of K computed as shown above. If this value of K is not given, it may be necessary to interpolate between curves. Beginning at the extreme right, follow this curve down to the point where it cuts the vertical line corresponding to the tube voltage used. Read at the extreme left the lead thickness to which this point corresponds.

Thus, in the example given above, having found $K = 0.33$, we select the curve in Figure 2 marked $K = 0.3$, because it is nearest to our computed value. Following this curve down to the point where it intersects the vertical line for 1,000 kv., we read off the required lead thickness—at the left margin of the chart—as 78 mm. or 3.1 inches.

By an identical procedure the concrete required for protection against direct x-radiation can be computed from Figures 3 and 4.

The procedure outlined above for computing K should be followed in all cases where no information is available as to the intensity of the useful beam. When this datum is given, a more exact estimate of protection is possible by taking this information into consideration. The curves in Figures 1–4, inclusive, were computed on the assumption that the x-ray tube output at various voltages is approximately that given in Table I.

TABLE I: X-RAY TUBE OUTPUT ASSUMED IN FIGURES 1–4

Tube Voltage (kv.)	Tube Output (r/minute ma. at 1 meter)
200	1
400	5
600	10
800	20
1,000	30
1,200	50
1,400	70

When the radiation intensity at one meter is known for any of the voltages listed in Table I, the value of K, as computed above, should be multiplied by the ratio of the known output of the tube in question at this voltage to that given in Table I for the same voltage. A new value of K is then obtained—it will generally be smaller than the original—from which the lead barrier required is found by following the instructions given above under B.

By way of example, suppose that in the case already cited, the tube output is known to be 15 r per minute milliampere at a distance of one meter. For 1,000 kv. the output assumed in Table I is given as 30 r per minute milliampere at one meter. The value of K already computed (0.33) should, therefore, be multiplied by the ratio 15/30, giving:

$$K = 0.33 \times \frac{15}{30} = 0.17$$

With the new value of K, a more exact estimate of the required lead or concrete can be obtained by following the procedure outlined under B. These values turn out to be 71 mm. or 2.8 inches of lead and 50 cm. or 19.7 inches of concrete.

Figures 3 and 4 are for concrete weighing 137 pounds per cubic foot (specific gravity 2.2). For other concrete mixes the thickness required varies inversely as the specific gravity or weight of the material per cubic foot. For example, let the thickness of concrete weighing 160 pounds per cubic foot be required. If from Figure 3 a concrete thickness of 50 cm. is found, then the thickness for the 160-pound concrete is computed as follows:

$$50 \text{ cm.} \times \frac{137}{160} = 43 \text{ cm.} = 17 \text{ inches}$$

Like concrete, such materials as brick, plaster, earth, water, etc., afford some degree of protection against x-rays and may be used either in place of lead barriers or in combination with them. At voltages above 200 kv., concrete, brick, and earth are frequently used without sheet lead. The combination of such materials with lead is, however, to be recommended wherever practicable, for several reasons. In the first place, there is always the possibility that cracks may develop in thick non-metallic walls; the addition of sheet lead to such walls reduces the radiation hazards should such cracks develop. Furthermore, relatively light barrier materials attenuate an x-ray beam by scattering, a process which involves, (*a*) the deflection of the radiation from its original path and (*b*) a reduction in its penetrating

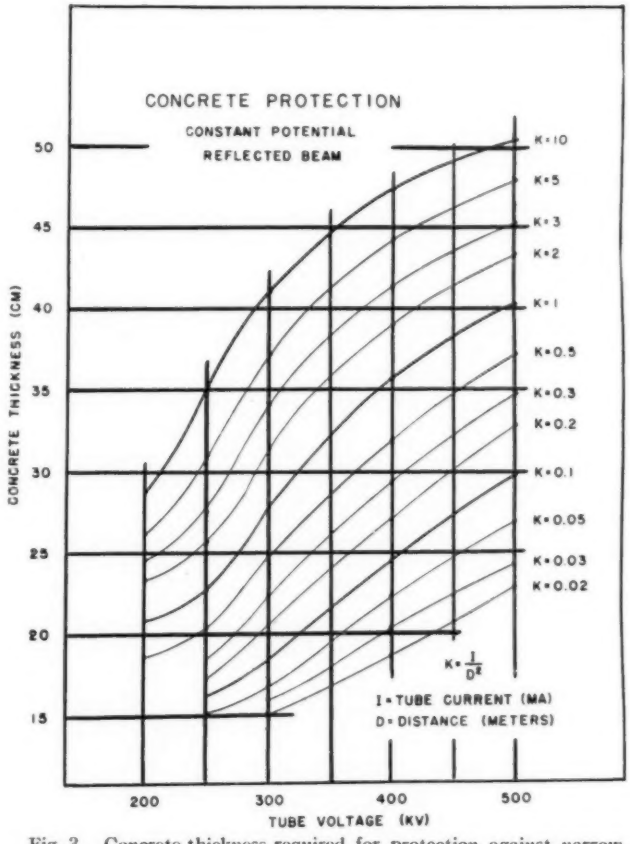

Fig. 3. Concrete thickness required for protection against narrow x-ray beams generated by voltages between 200 and 500 kv. for various distances between the tube target and operator.

power. Some scattering takes place in all materials and for all qualities of radiation, but this effect is more pronounced in relatively light materials and for very penetrating radiation. So, for example, scattering is greater for concrete than for lead and is greater for penetrating radiation than for relatively soft x-rays. From the point of view of x-ray protection, scattering is undesirable; when scattering occurs, a part of the x-radiation incident upon a barrier is scattered back upon persons within the protected space. The effect of back-scattering from concrete or brick walls can be reduced by adding a relatively thin layer of lead to the side of the protective barrier upon which the radiation is incident. Another advantage—but a secondary one—resulting from the use of such a lead "veneer" is that, on passing through it, the radiation is thereby hardened and, since concrete is relatively more effective for hard radiation than for soft, the concrete portion of the barrier becomes relatively more effective.

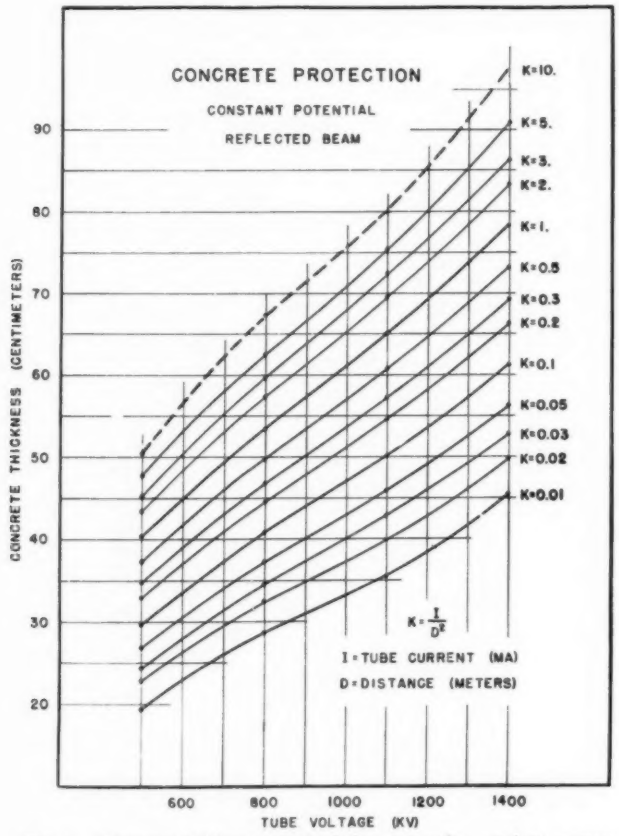

Fig. 4. Concrete thickness required for protection against narrow x-ray beams generated by voltages between 500 and 1,400 kv. for various distances between the tube target and operator.

Scattering also results in undesirable effects on the emergent side of concrete protective barriers. Radiation that penetrates barriers made of relatively light materials is less penetrating than the incident radiations. The addition of sheet lead on the far side of concrete barriers, therefore, effectively serves the purpose of absorbing the radiation which has pene-

trated the barrier and has been degraded in the process.

Effect of Beam Width on Relative Thickness of Concrete and Lead Required for Adequate Protection: In the foregoing paragraphs it has been assumed that the diameter of the x-ray beam against which protection is required is relatively small, of the order of 2 to 5 cm. In practice, x-ray beams as narrow as this are seldom used; this is true both in the medical and industrial applications of x-rays and is especially so in the latter field, where very broad beams are often used. Increasing the width of an x-ray beam makes it necessary to increase the thickness of the protective barriers beyond that required for adequate protection when narrow beams are used. This necessary increase in barrier thickness is not the same for all materials, being relatively greater for light materials such as concrete and brick, than for lead. Table II shows the ratio of the thickness of concrete to the thickness of lead required to reduce the incident radiation to the same extent—to a level of approximately 10^{-5} r/sec.—on the emergent side of the barrier. This table holds only for very narrow beams of x-radiation, of the order of a few centimeters in diameter.

TABLE II: RATIO OF THICKNESS OF CONCRETE TO THICKNESS OF LEAD REQUIRED FOR EQUIVALENT PROTECTION

Kilovolts	Ratio Thickness concrete / Thickness lead
75	74
85	67
90	65
100	60
110	63
115	65
120	67
125	68
150	72
160	74
200	55
250	34
300	25
400	16
500	12
600	9.3
700	8.1
800	7.1
900	6.5
1,000	6.1
1,200	5.6
1,400	5.2

The effect of increasing the diameter of an x-ray beam is to increase the ratio given in the second column of Table II. To say the same thing in another way, as the beam diameter is increased the percentage increase in the thickness of a concrete barrier must be greater than the corresponding increase in a lead barrier if the x-ray protection of both is to remain the same. This fact should be kept in mind when the data given herein are used, since narrow beams have been assumed throughout this discussion In making use of these data, the barrier thickness used should be greater than that recommended if the use of broad beams is contemplated. Exact information on the increase required when broad beams are used is not now available because of the technical difficulties involved in obtaining such information. The following is offered as a suggestion: that, when broad beams are used, the thickness of the barrier in question be increased by one half-value layer of the barrier material used for voltages up to 500 kv.; that for voltages between 500 and 1,000 kv., the barrier thickness be increased by two half-value layers; and for voltages between 1,000 and 1,500 kv., by three half-value layers.

Protection from scattered radiation should not be overlooked. A barrier between the x-ray tube and employees to protect them from the direct rays may not shield them from rays scattered by walls, ceiling, furniture, and other objects. This might happen, for example, in a one-story foundry building where a concrete barrier 7 feet high has been erected to stop the direct beam from the x-ray tube. If the unobstructed beam is directed toward the roof structure above the barrier, a part of the radiation will be scattered by the roof to reach the employees outside the barrier. This can be prevented by extending the barrier to the roof. The upper part, which need absorb only the scattered rays, can be much lighter than the lower part that must absorb the primary rays.

The intensity of scattered radiation reaching personnel will depend on many

TABLE III: PROTECTION AGAINST SCATTERED RADIATION

(Thickness of lead in inches required for protection against scattered radiation. Tube operated at 10 ma.)

Kv.	Scattered Rays			Rescattered Rays			Safe Distance No Shield
	3′	10′	20′	3′	10′	20′	
50	0.01	0.01	..	..	..	..	3′
75	0.02	0.01	..	0.01	..	..	4′
100	0.03	0.01	..	0.01	..	..	5′
140	0.05	0.01	0.01	0.03	..	..	7′
200	0.08	0.03	0.01	0.04	..	..	10′
250	0.12	0.05	0.02	0.05	0.01	..	15′
300	0.16	0.07	0.04	0.06	0.01	..	20′
400	0.22	0.15	0.08	0.07	0.01	0.01	25′
500	0.28	0.22	0.15	0.09	0.02	0.01	28′
600	0.35	0.30	0.20	0.11	0.03	0.01	33′
800	0.5	0.4	0.3	0.13	0.04	0.01	35′
1,000	0.6	0.5	0.4	0.15	0.05	0.02	....
1,400	0.6	0.6	0.5	0.17	0.06	0.02	....
2,000	0.7	0.7	0.6	0.20	0.07	0.03	....

factors, including the nature of the surface and the distances and directions that the rays must travel, as well as the kilovoltage and milliamperage of the source. It will always be weaker than the primary or direct radiation. It will also be less penetrating, particularly when high-kilovoltage apparatus is used. Lead is usually more economical and convenient than masonry or concrete for protection against scattered radiation only, and the thicknesses required are relatively small. Recommended thicknesses are tabulated in Table III for various kilovoltages of the apparatus and distances of the exposed scattering surface from the employees. In compiling this table, extremely unfavorable conditions were assumed, *e.g.*, that the scattering surface was close to the x-ray tube and of a material that scatters efficiently.

The distinction between singly scattered radiation and multiply scattered radiation is important. In the example above, of the tube behind a barrier 7 feet high, the rotation of the tube might be so restricted that the direct beam could not be pointed at the roof and hence it might not be possible for rays to get over the barrier without being scattered at least twice, for example, by both floor and roof. Doubly scattered radiation would be both weaker and less penetrating than singly scattered radiation, and, therefore, would require less lead to absorb it. The recommended thicknesses for mutiple scattering are given in Table III under the heading "Rescattered Rays." The final column gives the closest distance of safe approach to a wall emitting rescattered radiation when no protection intervenes.

The intensity of scattered radiation depends considerably on the material of the scattering surface. Ordinary structural materials like masonry, concrete, plaster, and wood scatter much more radiation than heavy metals like lead. For this reason it is desirable to cover all such surfaces likely to be exposed to direct radiation with lead. A thickness of 1/8 inch is suitable and sufficient for this purpose. Even 1/16-inch lead over a masonry wall gives considerable improvement.

EDITORIAL

Lowell S. Goin, M.D.

President of the Radiological Society of North America

The Radiological Society of North America would seem to have been most wisely guided that it has chosen Lowell Goin for its President exactly at this time, when the social and economic structure of medical practice is suffering critical strains. Rupture of the fabric seems imminent, even total solution, out of which must crystallize the pattern for the future. How it will crystallize depends largely on the men we choose to guide us. Lowell Goin has long been active in the affairs of his fellow physicians, a calm representative of their best interests; when the political waters were smooth, a pleasant friendly island; when the political storms blew hardest, a solid rock. Here is one man who seems comfortable in the chair with the gavel in his hand. This, I think, is not merely because he is a thorough parliamentarian, but also because he sees quickly and surely through every question to its ultimate implications. He is comfortable because he is rarely surprised.

Dr. Goin seems not to have bothered to send autobiographical notes to the various compendia, and I am indebted to John Crossan, his associate in medical practice, for most of the following data:

Lowell Sidney Goin was born in Charter Oak, Iowa, March 3, 1891, and received his education at the University of Iowa and St. Louis University, obtaining his M.D. degree in 1912, at the age of twenty-one. In 1915 he was already practising radiology and, when World War I came, he studied military radiology under George Johnson of Pittsburgh. He was made a captain in the Medical Corps and served a year and a half in France. Some of his personal experiences he has recorded in the *American Journal of Roentgenology* (**7** 128–130, 1920). After the war, he was for two years with James T. Case at Battle Creek, before the latter accepted a call to Chicago. Then there was an interlude of graduate work under Holfelder in Frankfurt, followed by practice in Peoria.

In 1925 Dr. Goin went to Los Angeles and was associated with William B. Bowman. It was during this time that he published his first paper in RADIOLOGY (**12:** 188, 1929). I haven't counted the papers he has published there and elsewhere since. After Dr. Bowman's death in 1930, Dr. Goin formed a partnership with Dr. Crossan, an association that has prospered and endured.

In 1922 Dr. Goin married Margaret Morehead in Salem, Virginia. Their elder son was lost in action over Vienna in October 1944. The younger is a senior in the Army and Navy Academy, Carlsbad, Calif.

Lowell Goin was the first Chairman of the Pacific Roentgen Society, and he and L. Henry Garland have always been its backbone and its lifeblood, too; very largely responsible for the good work it has done in crusading for proper relationship of Radiology to Medicine and to Hospital Management. Closely linked with this were his activities on the Intersociety Committee. He has been active on the staff of Queen of the Angels Hospital, where he is radiologist, having twice been its President and for seven years past the Chairman of the Board.

For six years he was Speaker of the House of Delegates of the California Medical Association and last year was its President. At the same time he was President

LOWELL S. GOIN, M.D.
President, Radiological Society of North America

of the American College of Radiology. This was a year of great responsibilities, as he understood them and acted under them, especially in regard to the development of "health insurance." He has set forth some of his ideas in *California and Western Medicine* (**62:** 246–249, May 1945).

With all this he has found time and energy to keep his interest in music and was for a time on the Board of Directors of the Los Angeles Chamber Music Society. And I feel sure he never has, and never will, let down in his enthusiasm for good living, good talk, and good friends.

R. R. NEWELL

CLEVELAND RADIOLOGICAL SOCIETY

The Cleveland Radiological Society co-operated with seven other interested groups in celebration of the fiftieth anniversary of the discovery of the roentgen ray. The other participating organizations were the Cleveland Medical Library, Academy of Medicine, Cleveland Dental Society, Western Reserve University, Case School of Applied Science, Cleveland Dermatological Society, and the Industrial Radium and X-ray Society.

Afternoon and evening sessions were held on Nov. 8 at the Cleveland Medical Library. Speakers at the afternoon session were Dr. Elmer Hutchisson on "Some Physical Aspects of the Roentgen Ray," Dr. Harry Hauser, on "The Roentgen Ray in Modern Medicine," Dr. Paul S. Sherwood on "The Roentgen Ray in Dentistry," and Dr. K. R. Van Horn on "Industrial Applications of the Roentgen Ray." The features of the evening session were the round table reminiscences of Dr. W. C. Hill, Dr. W. I. Le Fevre, and Dr. B. H. Nichols and an address on Wilhelm Conrad Röntgen by Dr. Otto Glasser.

An interesting exhibit was presented, illustrating the history and modern use of the x-ray, and this was open to the public on Nov. 11.

CANCER RESEARCH COMMITTEE ON GROWTH OF THE NATIONAL RESEARCH COUNCIL

As a result of action by the American Cancer Society designating the National Academy of Sciences as its scientific adviser for research, the National Research Council of the latter body has appointed a Committee on Growth, under the chairmanship of Dr. C. P. Rhoads.

The Committee announces the following major principles by which, so far as possible, it will be guided in its sponsorship of research and training programs:

(*a*) Desirability of long-term grants to projects of major importance.

(*b*) Grants, where possible, of such magnitude as to permit individual investigators to appoint associates for long-term training periods.

(*c*) Granting of fellowships to institutions for training of workers to acquire new techniques and wider experience.

(*d*) Maintenance of continuing individual contact with workers in field.

(*e*) Provision, on a participating basis, for continuing economic security for professional workers.

(*f*) Liberal attitude toward the investigator's work, his publication, and reports.

It proposes, furthermore, to arrange conferences of competent groups for discussion of problems, interchange of reports, etc.; to make surveys to analyze problems or to determine progress in areas of special interest pertaining to cancer; to evaluate, through study by subcommittees and by the main committee, basic and clinical research undertakings, and submit recommendations for support to the American Cancer Society; to initiate and plan broad or specific programs of basic and clinical research, and to secure the co-operative efforts of investigators in the general undertakings.

The Committee has established a central office in the Washington headquarters of the Council (2101 Constitution Ave., Washington 25, D. C.), where information on all phases of cancer research will be assembled and from which reports may be distributed to interested investigators.

THIRD ANNUAL WATTS HOSPITAL MEDICAL AND SURGICAL SYMPOSIUM

The Third Annual Watts Hospital Medical and Surgical Symposium will be observed Feb. 13 and 14, 1946, at Durham, N. C.

Clinico-Pathological Conferences will be held each day at 11 A.M. That on Wednesday will be conducted by Wm. B. Porter, M.D., and John S. Howe, M.D., of the Medical College of Virginia; that on Thursday by Henry B. Mulholland, M.D., and James R. Cash, M.D., of the University of Virginia Medical School.

Among the speakers are W. C. Davison, M.D., Dean of Duke University Medical School, on "Postgraduate Medicine"; Lt. Col. Louis Krause, Chief of Medicine, General Hospital, Camp Butner, N. C., on "Some Hemolytic Processes Including the Rh Factor"; Norris W. Vaux, M.D., Professor of Obstetrics, Jefferson Medical College, Philadelphia, on "The Treatment of Habitual Abortion"; Edward A. Strecker, M.D., Professor of Psychiatry, University of Pennsylvania Medical School, Philadelphia, on "Psychiatry Speaks to Democracy—About Mothers and Moms"; Arthur M. Shipley, M.D., Professor of Surgery, University of Maryland Medical School, on "Diverticulitis of the Colon"; James E. Paullin, M.D., Professor of Medicine, Emory University Medical School, Atlanta, Ga., on "The Relationship of Medical Practice to Gerontology"; Louis Hamman, M.D., Associate Professor of Medicine, Johns Hopkins Medical School, on "General Features of Periarteritis Nodosa, Particularly from the Standpoint of Diagnosis"; I. S. Ravdin, Professor of Surgery, University of Pennsylvania Medical School, on "The Pathologic Physiology of Biliary Tract Disease" and "The Surgical Aspects of Gallstone Disease"; Eugene P. Pendergrass, M.D., Professor of Radiology, University of Pennsylvania Medical School, on "The Roentgen Aspects of Biliary Tract Disease."

LEWIS GREGORY COLE, M.D. FRIEDENWALD MEDALIST

It is gratifying to record the presentation to Dr. Lewis Gregory Cole of the Friedenwald Medal of the American Gastroenterological Association, for 1945, in recognition of his outstanding contributions to medicine. Dr. Cole was a pioneer in radiology in America. His work with x-rays dates back to 1899, and his first paper, "Skiagraphic Errors: Their Causes, Dangers, and Prevention," was published in 1904. He has been a member of the Radiological Society of North America for twenty-five years.

BRONZE STAR MEDAL AWARDED TO DR. LAURISTON S. TAYLOR

On Oct. 20, 1945, Dr. Lauriston S. Taylor, Chief of the X-Ray Section, U. S. Bureau of Standards, was awarded the Army's Bronze Star Medal for meritorious service. Dr. Taylor was associated with the Operations Analysis Branch of the Army Air Forces, serving in the European theater of operations from May 1943 to June 1945.

The citation accompanying Dr. Taylor's award commended him for outstanding leadership, analytical ability, and technical skill demonstrated while he was chief of the Operational Research Section of the 9th Bombardment Division. Under his direction, the efficiency of lead crews increased, a highly efficient program of bridge interdiction was scheduled, and bombing accuracy greatly improved.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

The 1945 YEAR BOOK OF RADIOLOGY. Diagnosis, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor, WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital (on leave with the Armed Forces). Therapeutics, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 464 pages, with 342 illustrations. Published by The Year Book Publishers, Inc., Chicago, Ill. Price $5.00.

DR. W. C. RÖNTGEN. By OTTO GLASSER, Cleveland Clinic Foundation. A volume of 169 pages. Published by Charles C Thomas, Springfield, Ill., 1945. Price $4.50.

IIe CONGRÈS INTERNATIONAL DE LUTTE SCIENTIFIQUE ET SOCIALE CONTRE LE CANCER, BRUXELLES 20–26 SEPTEMBRE 1936. TRAVAUX SCIENTIFIQUES, publies sous la direction de MME. LE DOCTEUR MARTA FRAENKEL. Tome I. Rapports géneraux dans leur langue originale et suivis de résumés en six langues. Ligue Nationale Belge contre le Cancer, Bruxelles, 1936.

PHYSICAL CHEMISTRY OF CELLS AND TISSUES. By RUDOLF HÖBER, University of Pennsylvania School of Medicine, Philadelphia. With the collaboration of DAVID I. HITCHCOCK, Yale University School of Medicine, Laboratory of Physiology, New Haven, Conn., J. B. BATEMAN, Mayo Clinic, Rochester, Minn., DAVID R. GODDARD, University of Rochester, Biological Laboratories, Rochester, N. Y., and WALLACE O. FENN, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y. A volume of 676 pages, with 70 illustrations. Published by The Blakiston Company, Philadelphia. Price $9.00.

Book Reviews

THE OSSEOUS SYSTEM. A HANDBOOK OF ROENTGEN DIAGNOSIS. By VINCENT W. ARCHER, M.D., Professor of Roentgenology, University of Virginia, Department of Medicine. A volume of 320 pages, with 148 plates. Published by The Year Book Publishers, Inc., Chicago, 1945. Price $5.50.

In The Osseous System, which is the fourth of a projected series of six Handbooks on Roentgen Diagnosis to be issued under the imprint of the Year Book Publishers, Dr. Archer combines interest with instruction. As a handbook should, this volume of modest proportions deals with an extensive field concisely but adequately, covering all the essential features but making no attempt at a detailed exposition of every phase of the subject.

The contents are divided into five main sections: (1) Technic; Principles of Interpretation; Roentgen Anatomy; (2) Injuries to the Skeletal System Other than the Spine; (3) The Spine; (4) Bone Diseases and Abnormalities in Childhood; (5) Bone Diseases Occurring Principally in Adult Life.

In the second and third sections the material is arranged in general on a regional basis. The various bones of the skeleton and the different areas of the spine are taken up separately. In each instance there is an introductory section on the best technic for the area in question, followed by remarks on the roentgen anatomy and the physiological changes, injuries, and diseases likely to be encountered. Personal observations, showing the background of a long and valuable clinical experience, add greatly to the value of the discussions.

In the section on bone disturbances in children

the conditions are grouped somewhat loosely according to the predominant radiologic characteristics, as periosteal thickening, increase in bone density, developmental defects, etc. A somewhat similar plan is followed in the section on bone diseases in adults.

The book is amply illustrated, lists of references are supplied, and there is a useful index. Dr. Archer dedicates his book to "the occasional radiographer." It should prove valuable not alone to that group, but to all radiologists seeking a concise review of the roentgen aspects of bone lesions.

THE INTERVERTEBRAL DISC, WITH SPECIAL REFERENCE TO RUPTURE OF THE ANNULUS FIBROSUS WITH HERNIATION OF THE NUCLEUS PULPOSUS. Second Edition. By F. KEITH BRADFORD, M.D., Houston, Texas, and R. GLENN SPURLING, M.D., Louisville, Kentucky. A volume of 192 pages, with 70 illustrations. Published by Charles C Thomas, Springfield, Ill., 1945. Price $4.00.

In this small volume the authors have assembled all the important information which has been accumulated regarding the intervertebral disk and its disturbances. The average reader will be most interested in the chapters on the clinical and roentgenological investigation of the patient, treatment, and results. For those desiring to obtain a more comprehensive knowledge of the subject there are introductory chapters on the embryology, anatomy, physiology, and pathology of the intervertebral disk.

This second edition has been brought up to date by comments regarding the use of pantopaque in myelography and a discussion of the findings associated with small, lateral, cervical herniations of the nucleus pulposus resulting in severe pain in the neck and arms. The bibliography at the end of the volume now contains 307 references, as compared with 258 papers referred to in the first edition.

As the authors mention, there remain several controversial points regarding this subject. For one thing, there is not yet general agreement as to the name of the clinical pathological entity under discussion. The name suggested in this volume, "rupture of the annulus fibrosus with posterolateral (or posterior) herniation of the nucleus pulposus," seems too cumbersome to become generally accepted. It is correctly stated that it is too early as yet to evaluate the late results of operative treatment. Likewise, the question as to whether spinal fusion should be combined with removal of the herniated nucleus is not definitely decided. Lumbar puncture as a possible cause of herniation of the nucleus pulposus is discussed, and although no reported cases have been attributed to this cause, it is felt to involve distinct danger, which should be avoided by careful technic.

The material is presented in an interesting, readable manner, free from tiresome repetition and with numerous helpful illustrations. Anyone familiar with the information contained in this monograph should have little difficulty in making the proper diagnosis in the usual case of herniated nucleus pulposus.

Fauntleroy Flinn, M.D.

In Memoriam

FAUNTLEROY FLINN, M.D.

1890–1945

Dr. Fauntleroy Flinn, of Decatur, Ill., died on July 26, 1945. Dr. Flinn was born in Alberta, Va., and was educated at Randolph-Macon College and the Medical College of Virginia. He was associated with the U. S. Public Health Service, Hospital No. 32, in 1920–22 and with the U. S. Bureau of Mines from 1922 to 1926. From 1926 until his death he was Director of the Department of Radiology, St. Mary's Hospital, Decatur, Ill. He was, also, from 1930, radiologist at Wabash Employees' Hospital.

Dr. Flinn served as a member of the Advisory Board for the Division of Cancer Control of the Illinois Health Department and as radiologist on the Selective Service Medical Advisory Board for his state. He was a fellow of the American College of Radiology and a member of the Radiological Society of North America and of the Illinois Radiological Society. He was a member, also, of the Decatur Trail Riders Association.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N.Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Gordon King, M.D., Children's Hospital, San Francisco.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Acting Secretary, Frederick H. Rodenbaugh, M.D., 490 Post St., San Francisco. Meets annually with California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., U. S. Naval Hospital, San Diego, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month, Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, J. F. Pitman, M.D., Blanche Hotel Annex, Lake City.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meets in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Cedar Rapids. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Charles N. Davidson, M.D., 101 West Read St., Baltimore 1.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

Michigan Association of Roentgenologists.—Secretary, Bruce MacDuff, M.D., 201 Sherman Bldg., Flint 3.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

St. Louis Society of Radiologists.—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society.—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hos-

pitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

New Hampshire Roentgen Society.—Secretary-Treasurer, Richard C. Batt, M.D., St. Louis Hospital, Berlin.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., East Rockaway, L. I.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo A. Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gian Franceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings in January, May, and October.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Wm. Snow, M.D., 941 Park Ave., New York 28.

Rochester Roentgen-Ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meets in May, and October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, Charles Heilman, M.D., 1338 Second St., N., Fargo.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Carroll C. Dundon, M.D., 2065 Adelbert Road, Cleveland 6. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

Philadelphia Roentgen Ray Society.—Secretary, Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

Pittsburgh Roentgen Society.—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24. Meets second Wednesday of each month at 6:30 P.M., October to May, inclusive, at The Ruskin, 120 Ruskin Ave.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth, 4. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, M.D., Baylor Hospital, Dallas.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society in September.

University of Wisconsin Radiological Conference.—Meets first and third Thursdays, 4 to 5 P.M., September to May, inclusive, Room 301, Service Memorial Institute, 426 N. Charter St., Madison 6.

CANADA

Canadian Association of Radiologists.—Honorary Secretary-Treasurer, J. W. McKay, M.D., 1620 Cedar Ave., Montreal.

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meets monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Adrenals

The Musculoskeletal System

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Diffuse Neurofibromatosis (von Recklinghausen's Disease) Involving the Bulbar Conjunctiva. Report of a Case, with Lesions of the Skeletal System and Skin, Bodily Asymmetry and Intracranial Involvement. Francisco Páez Allende. Arch. Ophth. **33:** 110–115, February 1945.

A case of diffuse neurofibromatosis (von Recklinghausen's disease) involving the bulbar conjunctiva, with histologic confirmation, is reported. The patient, an 18-year-old girl, the twin of an apparently healthy boy, also presented asymmetry of the body, cutaneous tumors, partial alopecia of the scalp on the side of the affected eye, skeletal lesions, intracranial involvement, and epilepsy. The lesions were congenital.

Roentgenograms, which are reproduced here, show a craniofacial asymmetry, with protrusion of the region corresponding to the scala of the right temporal bone. The right orbit is larger than the left. The cranium tends to be tower-shaped, owing to the greater development of the dome than of the base. The frontoparietal region is thinned, with little difference in the layers of bone, through atrophy of the diploe and accentuation of the inner cortical layer. The middle fossa of the cranium is asymmetric, being deeper on the right side, due to internal compression by the right temporal bone. The sella turcica is larger than usual, especially in the anteroposterior diameter. It is deformed, particularly at the expense of the posterior clinoid processes. The venous furrows in the right parietal region are accentuated, and "digitate" impressions are present in the left frontoparietotemporal region. On the right side a series of calcium shadows extends from the middle fossa of the cranium to the vertex; some of these are semicircular and give the impression of being clustered. These calcifications probably circumscribe a series of neurofibromatous endocranial formations. The pelvis appears moderately asymmetric, owing to the lesser development of the bones which form the left side of the pubis.

X-ray studies of the chest were normal. The bones of the right arm were more developed than those of the left arm; the left leg was shortened. The inner surface of the upper third of the left tibia presented exostoses.

A photomicrograph of the conjunctival tumor is reproduced.

Characteristic Roentgenographic Changes Associated with Tuberous Sclerosis. W. W. Dickerson. Arch. Neurol. & Psychiat. **53:** 199–204, March 1945.

Tuberous sclerosis is one of the entities to be given consideration in differential diagnosis when multiple focal calcium deposits are observed in skull roentgenograms. It has been pointed out and widely accepted that such concretions are located within the brain substance. Dickerson, on the other hand, states that a more characteristic finding in the disease consists of patchy areas of increased density within the calvarium itself. This observation is proved beyond doubt by careful examination of autopsy material from three patients with typical signs of tuberous sclerosis. Histologically, the diseased areas in the skull showed osteosclerosis and replacement of normal bone marrow by fat. Many, if not all, of these islands of abnormal bone appeared to overlie tuberous nodules in the cerebral cortex.

It is suggested that the calvarial changes are related to puberty in some manner, but no further explanation is offered.

JOHN F. HOLT, M.D.
(University of Michigan)

Aerosinusitis—A Résumé. Paul A. Campbell. Ann. Otol., Rhin. & Laryng. **54:** 69–83, March 1945.

Prior to World War II with its emphasis upon high altitude flying and the institution of an Altitude Training Program based on simulated flight, barometric pressure changes were of chief concern in caisson workers and deep-sea divers, where they manifested themselves more spectacularly in decompression sickness and anoxia. The aerosinusitis which may be produced by differences in barometric pressure between the air or gas within the sinuses and that of the surrounding atmosphere is commonly characterized by congestion and inflammation of the lining structures, frequently with pain over the sinus area and with or without mucosal or submucosal hemorrhage. The frontal and maxillary sinuses are the sites of predilection.

Two types of aerosinusitis are recognized: a non-obstructive form due to the presence of pus, fluid, or mucus covering the ostium of the sinus, and an obstructive form due to a blocking of the ostium by redundant tissue or an anatomical defect. In the first type the change in pressure incident to descent may press the fluid or other material into the sinus, and infection of the lining mucosa may ensue, though this is rather unusual unless the membranes have been severely barotraumatized, their natural immunity lowered, or they are insulted by virulent organisms. In the second type, the mechanism may be that of a flap valve formed by a small polyp or a bit of tissue. During ascent the flow of air or gaseous content is outward, and the flap is merely pushed aside and the pressure equalized. On descent, however, the flap is pressed against the ostium by the heavier outside atmosphere (or sucked in by the lighter inside air) and an airtight seal is formed. Swelling of the mucosa and fluid production represent an attempt to equalize the inner and outer pressures. As soon as sufficient space is filled, the flap valve is released and recovery begins.

The author presents a series of roentgenograms from a patient with mucosal hematoma formation. The x-ray picture made following an altitude chamber flight shows a large dome-shaped swelling of mucous membrane in the left frontal sinus not present earlier. Subsequent films demonstrated a slow resolution of the process with complete recovery after about five months. The roentgenographic findings in non-obstructive aerosinusitis are, in most instances, not diagnostic, as the amount of fluid or pus pressed into the sinus is never large.

Aerosinusitis must be differentiated from purulent and catarrhal sinusitis. A history of pain over one or more of the sinuses during or shortly after exposure to extensive barometric pressure change is suggestive, as is epistaxis during or after such exposure. Roentgenologic plates disclosing opacity or a thickened lining membrane in the absence of previous sinusitis are strongly indicative of the diagnosis.

The milder cases of this manifestation of barotrauma are self-limited, resolution taking place in from a few hours to a few days. The author makes some suggestions as to prophylaxis and treatment but concludes that the ultimate solution of the problem lies with the aeronautical designer and engineer.

STEPHEN N. TAGER, M.D.

Osteoma of the Frontal Sinus. Report of Five Cases. James R. Dowling. Arch. Otolaryng. **41:** 99–108, February 1945.

Primary osteoma of the frontal sinus is not a common lesion. Since the majority of case reports appear in the European literature and 2 of the 5 patients in the present series were German prisoners of war, it may be that the lesion occurs more frequently among Europeans than among Americans. Males are more commonly affected, usually in the second and third decades of life. The etiology is obscure. Embryonic rests, trauma, and repeated infections of the frontal sinus, resulting in abnormal activity initiating tumor formation, have been suggested as possible causes. The presence of an osteitis of the frontal bone over a small area lateral to and above the upper margin of the sinus in 2 of the author's cases lends support to the last theory. The 5 cases are presented in full, with numerous illustrations.

Osteoma is a slow-growing benign tumor. It is malignant only mechanically, *i.e.*, through its capacity of enormous development and its situation in direct proximity to vital organs. Morphologically two types are recognized—the hard, ivory-like, eburnated type and the softer cancellous one. Microscopically, there may be great variations.

The greater number of cases of osteoma reported in the last few years is not in the author's opinion an indication that the tumor has become more common but is attributable to more frequent roentgen examination, with the discovery of cases which otherwise would have been undiagnosed. The lesion is often present a long time before any symptoms appear. Dizziness, headaches, and deformity may occur. The tumor may extend externally through the outer table, internally into the anterior cranial fossa, or inferiorly into the orbit. The symptoms are determined by the structure upon which the pressure of the expanding growth is exerted.

The only treatment for osteoma of the frontal sinus is surgical removal. When the tumor is small and asymptomatic, it is possible to observe the progress by repeated roentgen examinations. If the entire sinus is involved, with or without extrasinal involvement, surgical intervention should not be too long deferred. Three of the author's patients were operated upon with good results.

Problems in X-Ray Localization of Foreign Bodies In and About the Eye. J. A. MacMillan. Canad. M. A. J. **52:** 173–175, February 1945.

Radiographs should be made of all patients suspected of having a foreign body in or about the eye. Anteroposterior and lateral films should be made and, if the foreign body cannot be definitely placed outside the globe, a localizing procedure should be done. This should show whether the foreign body is within or outside the globe and whether there has been any change in position after failure of magnet extraction; it should also determine the closest proximity of the foreign body to a point in the sclera from which it may be removed. The author describes briefly several general methods for x-ray localization. He considers the Sweet method as the most accurate, but since the apparatus is expensive and is not generally available, he suggests some of the simpler procedures, as the contact lens method of Comberg, as perhaps best for smaller medical centers.

The records of the author's last 100 patients with intraocular foreign body are reviewed. Fifteen of these had perforating lesions of the globe, making x-ray study unnecessary. In 16 others, accurate localization was not done. In 30 of these 31, the foreign bodies were removed by magnet extraction. In the remaining 69 cases, the Sweet method of localization was used. In one, the foreign body was not shown, though it was subsequently removed by the magnet. In 3, the foreign body was localized outside the globe, but was removed from the globe by the magnet. In 7 cases the foreign body was non-magnetic, and in 2 of these enucleation was required. In 20 of the series of 100, enucleation was necessary and in 55 cataracts developed.

The author notes that in one case, a BB shot was removed by the magnet, and he points out that, since some of these shot are made of magnetic metal, the magnet should be tried in all cases where shot is present.

BERNARD S. KALAYJIAN, M.D.

THE CHEST

Bronchography as a Diagnostic Aid in Chest Disease. George S. McReynolds, Jr., and Fred W. Shelton. Ann. Otol., Rhin. & Laryng. **54:** 114–124, March 1945.

In diseases of the chest, bronchography with one of the iodized oils to outline the tertiary bronchi and the peripheral bronchial tree provides additional information concerning areas inaccessible to vision through the bronchoscope.

In adults, the procedure is carried out under local anesthesia (pontocaine in a 2 per cent solution, without epinephrine). The catheter method described by Jackson and Bonnier (Ann. Otol., Rhin. & Laryng. **46:** 771, 1937) is used, the oil being introduced under fluoroscopic guidance. Only one lung is filled at a time, and both anteroposterior and lateral views are taken.

In children, the authors have successfully used iodized oil instillation under general (ether) anesthesia. With the patient in third-stage anesthesia, the larynx is exposed with a laryngoscope and the bronchoscope is introduced. A flexible-tipped bronchial aspirator is passed through the bronchoscope and any secretion in the bronchial tree is aspirated. The syringe containing the iodized oil is then connected to the aspirator and the oil is injected, under fluoroscopic visualization, into the desired lobe or lobes. X-ray films are taken at once, without moving the child. Usually both the right and left bronchial trees are filled at one time to obviate the necessity of repeating the general anesthetic, though this is a matter to be determined in the individual case. The procedure should not be used in acutely ill children, and the acute exudative form of pulmonary tuberculosis has generally been considered a contraindication, though the present trends in endoscopy in pulmonary tuberculosis tend to dispel the fear of using iodized oil in acid-fast infections.

Illustrative cases in both adults and children are recorded.

The author does not consider bronchography as a substitute for bronchoscopy but as an adjunct. A

diagnostic bronchoscopy should invariably precede the instillation of iodized oil. STEPHEN N. TAGER, M.D.

Early Diagnosis of Diseases of the Chest. Norman J. Wilson. New England J. Med. **232:** 301–309, March 15, 1945.

Mass surveys of the chest have shown that many patients have subclinical disease which is in a curable stage, particularly tuberculosis and carcinoma. The mass survey should find early lesions, and pooled specimens of sputum, gastric aspiration, bronchography, bronchoscopy, and biopsy should establish the diagnosis.

The high value of the mass x-ray survey is indicated by the fact that in large series of hospital admissions about 9 per cent of the patients will have significant thoracic disease, while routine blood counts show only about 1.0 per cent blood dyscrasias, urinalysis reveals diabetes in about 0.4 per cent, and routine serologic tests show syphilis in about 2.0 per cent.

JOHN B. MCANENY, M.D.

Advantages of Supplemental Radiographic Studies at Time of Induction. A. C. Galluccio. Mil. Surgeon **96:** 262–265, March 1945.

A study of 366 pre-inductees was made to determine the desirability and practicability of adding other roentgenographic studies to the present single x-ray examination of the chest at induction. Thirty per cent of the men examined were found to have pathema of some degree. Fifty-two of 103 roentgenograms of the lumbar spine and abdomen showed some abnormality; in 24 of these cases congenital anomalies of the lumbosacral area of varying extent and significance were found. In only 27 of the 145 gastro-intestinal series, on the other hand, were the findings such as to warrant this type of examination.

The men in this series were referred for roentgen study because of some abnormality in the clinical picture. Any large number of inductees routinely examined would naturally show a much lower percentage of positive findings.

An analysis of the data obtained would seem to indicate the desirability of supplementing the routine chest film at induction with a flat film of the abdomen taken in the supine position. This would reveal the presence of congenital anomalies of the lumbosacral area, which are important because of their frequency and their association with low back pain and limitation of motion. It would also be helpful to all concerned to know, for example, that a soldier complaining of pain in the dorsal area after one year of service had minimal osteoarthritic changes on induction, or that the induction film of a soldier with renal colic did or did not reveal a calculus. This information as to the time of origin of the disease process or injury would be of aid in evaluating claims for pension benefits, and the slight added initial cost to the government would be amply repaid.

Tuberculosis in the Canadian Army 1939 to 1944. J. D. Adamson, W. P. Warner, R. F. Keevil, and R. E. Beamish. Canad. M. A. J. **52:** 123–127, February 1945.

This study is one of the incidence of tuberculosis in the Canadian army, with a comparison of the findings among troops stationed in Canada with those overseas. In all of the troops, there has been a gradual but definite increase in incidence in the past five years. The increase may be more apparent than real, however, since more thorough methods for study of suspected cases and contacts have been applied. This is indicated by the fact that the percentage of minimal lesions discovered has more than doubled, 55 per cent in 1944 as compared with 27 per cent in 1942.

The incidence of all forms of tuberculosis has been found to be greater among the overseas troops than in those stationed in Canada. In the latter group, the incidence corresponds very closely to that of the civil population. Overseas troops coming from the provinces of Canada where the civil death rate from tuberculosis is low almost invariably show a greater incidence of all forms of the disease than those from provinces where the civil death rate is relatively high. The total rates for all forms of tuberculosis are roughly twice as high overseas as in Canada, undoubtedly due to greater opportunity for exposure to open cases in the countries to which these troops have been sent.

BERNARD S. KALAYJIAN, M.D.

Mass X-Ray Survey in San Antonio. David M. Gould. Public Health Rep. **60:** 117–126, Feb. 2, 1945.

In 1942, a tuberculosis survey was carried out in San Antonio, which has had the highest tuberculosis death rate of any large city in the United States, a 35-mm. photofluorographic unit being employed. A 14 × 17-inch chest film was taken in suspicious cases. This survey revealed that 993 (4.9 per cent) of the 20,350 persons examined had reinfection tuberculosis, minimal, moderately advanced, or far advanced. In addition, 200 persons (1.0 per cent) were found to have cardiac abnormalities; 91 (0.4 per cent) had massive calcification; 258 (1.3 per cent) suspicious tuberculosis; 125 (0.6 per cent) fibrosis; and 102 (0.5 per cent) had other types of chest disease.

Of the 20,350 persons examined, 12,920 were female and 7,430 were male; of the females, 4.7 per cent had reinfection tuberculosis; of the males, 5.2 per cent. Over 90 per cent of the series were of Latin-American extraction; only a small number were Negroes. Very slight differences in the proportion of reinfection tuberculosis were observed between the Anglo-Americans and the Latin-Americans. The true incidence of tuberculosis among the Anglo-Americans in San Antonio is probably lower than the figure obtained in this survey, because of the relatively small numbers examined and because the few that presented themselves made a considerable effort to seek out the survey in the Latin-American quarter. The most obvious reason why one Latin-American out of 20 was found to have tuberculosis is poverty, with accompanying unsanitary living conditions, inadequate diet, and lack of medical care.

Tuberculous Pleurisy with Effusion in Infancy. Janet B. Hardy and Edwin L. Kendig, Jr. J. Pediat. **26:** 138–148, February 1945.

A diagnosis of pleurisy with effusion was made in 13, or 3.3 per cent, of 393 children with tuberculosis at the Harriet Lane Home, Baltimore. The age of the patients at the time the effusion occurred ranged from ten to twenty-eight months. The incidence in Negro children was 4.2 per cent; in white children, 1.5 per cent. The demonstration of tubercle bacilli by culture or guinea-pig inoculation of the pleural fluid provided positive proof of the diagnosis in slightly less than one-half of this series. Calcification in the pleura after disappearance of the fluid completed the diagnosis in one patient.

In the rest, a positive tuberculin test, the demonstration of a pleural effusion, and the subsequent course of the disease were considered sufficient. The cases in this last group are presented in detail. In none of the patients was there evidence of any disease which might be construed to be due to some organism other than the tubercle bacillus. Roentgenograms showed a fibrinous pleurisy in 32 other children in this series.

Since all the children in the series were under twenty-nine months of age when the pleurisy developed, it is obvious that the tuberculous process could not have been of long standing. The duration of the effusion varied between one and twelve months, with the majority lasting less than six months. As far as could be determined, the occurrence of pleurisy with effusion was without effect on the ultimate prognosis.

Primary Atypical Pneumonia: A Critical Analysis of 500 Cases. Saul Karpel, Irving M. Waggoner, and Oswald S. McCown, Jr. Ann. Int. Med. **22:** 408–417, March 1945.

A detailed analysis of 500 cases of primary atypical pneumonia is presented. In over 70 per cent of the series, the onset was insidious. The more usual initial symptoms of those developing a moderately severe infection are, in the order mentioned, malaise, chilliness, headaches, rhinitis, sore throat and cough, accompanied by substernal pain or heaviness. The almost complete absence of cyanosis, dyspnea, and abdominal distention deserves mention in contradistinction to the frequency of these findings in lobar pneumonia, especially prior to the introduction of the sulfonamide drugs. Fever is less marked than in the latter disease and is not sustained at so constant a level. Sputum is mucoid or mucopurulent, not rusty. The normal leukocyte count, negative sputum and blood culture, lack of physical signs of consolidation, typical roentgen-ray appearance, and lack of response to sulfonamide medication are further differentiating factors.

The authors stress the point that many cases will escape detection unless roentgen-ray facilities are freely used. In their experience, the first chest film generally showed increased markings or increased peritruncal shadows compatible with a respiratory infection. Subsequent films, after twenty-four to forty-eight hours, registered the pneumonic infiltration. The characteristic finding is a soft shadow radiating from the bronchial trunk. Involvement of an entire lobe may occur, but in the typical case the process is limited to a portion of a lobe or lobes. The density of the shadows and complete lobar involvement seen in true lobar pneumonia were infrequently observed in this series.

In 52.8 per cent the involvement was in the right lower lobe. The left lower lobe was the site in 39.6 per cent, right middle lobe in 11.6 per cent, right upper lobe in 9.4 per cent, and left upper lobe in 6.2 per cent. In 22.2 per cent two lobes were involved, in 2.2 per cent three lobes, and in 1 per cent all lobes. Four-lobe involvement was not recorded.

In the majority of cases, resolution of the pneumonic process was observed by repeated roentgen-ray examinations. This required from as little as two days to sixty days. There was a single death in this series (0.2 per cent), and complications developed in less than 3 per cent. Bronchiectasis was found in about 2 per cent. A report of the fatal case is included, with autopsy findings.

STEPHEN N. TAGER, M.D.

Pleuritic Involvement Associated with Primary Atypical Pneumonia: A Roentgenographic and Clinical Study. Arnold L. Bachman, Nathan O. Sara, and Harry E. Mantz. Am. J. Roentgenol. **53:** 244–258, March 1945.

Of 144 ambulatory patients with primary atypical pneumonia, 21 (14.5 per cent) showed definite roentgenographic evidence of involvement of the pleura. In the majority of these, there was a thickening of the lower ends of the long fissures, probably due to exudate. In 11 patients pleuritic involvement was essentially limited to the lower end of the longitudinal fissure with little or no roentgen evidence of an adjacent pulmonary parenchymal process. Seven cases showed an atypical pneumonic infiltration associated with the thickening of the lower end of the long fissure, involving either the lobes adjacent to the fissure or the opposite lung. In 3 cases the costophrenic sinus was the site of the pleuritis. In 1 of these there was a considerable effusion in the general pleural space.

The patients were soldiers eighteen to twenty-six years of age. Symptoms were those of a mild respiratory infection, and the patients were not incapacitated. A few had a pleuritic type of chest pain on deep inspiration. Physical findings were meager. Laboratory examinations were normal in the great majority of instances. In most cases a normal chest roentgenogram was obtained after two to four weeks.

The roentgenographic appearance of thickening of the lower end of the long fissure, due to exudate and/or moderate effusion, was quite characteristic. The frontal view showed a rather limited area of homogeneous density in the lower lung field, adjacent to the heart, always extending down to the diaphragm in the cardiophrenic angle. In the left lung blurring of the usually sharp left lower cardiac border was uniformly observed. In the lateral view the density was in the region of the junction of the diaphragmatic shadow with that of the anterior chest wall, extending upward for a variable distance along the course of the interlobar fissure. In the left anterior oblique view, the thickened lower end of the right long fissure was seen as a rather homogeneous triangular opacity in the anterior portion of the right lower lung field, adjacent to the lower right cardiac outline. For the left side the right anterior oblique position is employed. The heart shadow somewhat obscures the band-like density of the long fissure, and the homogeneous triangle of density due to the thickened pleura was considerably smaller than on the right side. In a large number of cases, roentgenographic evidence characteristic of atypical pneumonia was found to be associated with the pleural exudate.

Conditions to be differentiated are (1) middle lobe pneumonia, (2) atelectasis, (3) involvement of the lower anteromedial portion of the left upper lobe adjacent to the interlobar fissure and near the heart, (4) infiltrations in the lower lobes mesially, near or behind the heart. The lateral and oblique views are most valuable and are essential in making these differentiations.

CLARENCE E. WEAVER, M.D.

Primary Coccidioidomycosis. A Possible Pediatric Problem. Ralph H. Kunstadter and Robert C. Pendergrass. J. A. M. A. **127:** 624–627, March 17, 1945.

Primary coccidioidomycosis may be considered to pass through three phases: the acute stage, the subacute or chronic active stage, and the arrested or healed stage. The first stage, occurring usually two to three

weeks after the initial infection, is characterized by acute respiratory disease frequently associated with erythema nodosum and/or erythema multiforme, and arthritic symptoms. The subacute or chronic active phase follows the disappearance of acute clinical manifestations, while roentgen evidence of pulmonary activity persists. This period lasts from weeks to months. In the third stage, clinically silent lesions may be demonstrated roentgenographically.

The roentgen findings in primary coccidioidomycosis vary, but the initial pulmonary infection commonly resembles childhood tuberculosis or bronchopneumonia. One of the more common manifestations of the chronic stage is the appearance of single or multiple nodular lesions in the lung, which may be confused with nodular tuberculous lesions or metastases from a primary tumor. Careful study of the roentgenograms with a magnifying lens will usually reveal serration of the edges of the lesions.

With modern rapid transportation facilities and increase in migration of populations, coccidioidomycosis may be seen throughout the entire United States. The possibility of this infection, particularly in children returning from endemic areas in the Western states, should be kept in mind.

Silicosis in Foundries of Naval Gun Factory. Edwards M. Riley, Robert W. Butler, and Sidney Goren. U. S. Nav. M. Bull. **44:** 653–660, March 1945.

Two silicosis surveys were made at a naval gun factory, one in 1939 and one in 1944. The 1939 survey showed 11 cases of silicosis among 454 employees, an incidence of 2.4 per cent. In addition, there were 17 borderline cases (3.7 per cent). Eleven cases of tuberculosis were found (2.4 per cent). It is clear, in view of these findings, that definite silicosis hazards existed despite the fact that the majority of the employees shown to have the disease had had longer service in other factories than in Navy Yards. Between 1939 and 1941, the number of men in the steel foundry was almost tripled and certain active measures were subsequently taken to reduce the dust hazard, which was visibly increased with this enhanced activity. The effectiveness of these measures was shown by greatly reduced dust counts in the various occupational groups, the average reduction being approximately 65 per cent.

In the 1944 survey, 895 workers were examined; 842 were studied roentgenographically, with 4 × 5-in. stereoscopic films. All cases showing evidence of pathological change were restudied, the procedure including a detailed history, physical examination, and 14 × 17-in. films. Of the 895 workers, 63 per cent had been exposed to dust for a period of time normally considered long enough for development of silicosis. However, only 18, or 3.2 per cent of this group (2.1 per cent of the total group), showed any evidence of silicosis. Of these, 15 were in stage one, 2 in stage two, and 1 in stage three. In both stage-two cases, the disease was undoubtedly present before employment in the Navy Yard, but since routine pre-employment examinations and chest radiographs were not made prior to this time, the condition had not been discovered. A large percentage of the patients are symptom-free and those few complaining of cough proved to be excessive smokers. Thirteen cases of tuberculosis (1.5 per cent) were found in this second survey.

BERNARD S. KALAYJIAN, M.D.

Pulmonary Roentgenographic Changes Due to Mitral Stenosis Simulating Those Due to Silicosis. Henry W. Ryder and H. G. Reineke. Am. Heart J. **29:** 327–338, March 1945.

The authors present a case in which a diagnosis of silicosis had been made, based on three different x-ray examinations, prior to their observation. The patient, a white male, aged 26, had not been engaged in any occupation considered as a dust hazard prior to April 1943. At the time of the original diagnosis (July 1943) he had been employed for eighty-three days in a building in which a crusher of filter material was operated. The filter material consisted of finely ground silica, with a binder of potassium silicate. It was received in large pieces and crushed to lumps about the size of a finger tip. The silica was not ground and the filter material was not prepared at this site. Exhaust ventilation was in practice and the operation was not considered a dusty one. The major part of the patient's work was done at some distance from the crusher.

The case came to the authors' attention in October 1943. At that time a physical examination showed the aortic sound, pulmonic sound, and second heart sound at the mitral area to be widely split. The first sound at the mitral area was markedly accentuated; the pulmonic second sound was sharp and accentuated. There was a rumbling holodiastolic bruit, with presystolic accentuation at the apex. In the absence of aortic insufficiency, this bruit was interpreted as being pathognomonic of mitral stenosis. EKG changes were present. Roentgen examination of the chest showed diffuse mottling, an accentuation of the pulmonary conus, and an enlargement of the left auricle.

This case is presented as illustrative of the fact that repeated roentgen studies are not of themselves sufficient basis for a diagnosis of silicosis. Hazardous exposure to silica dust had not occurred, clinical evidence of pulmonary disease was lacking, and the roentgen changes proved to be those of pulmonary congestion resulting from mitral stenosis.

The authors quote a number of authorities on the pulmonary changes in mitral stenosis, with special reference to the occasional case with a miliary appearance strongly suggestive of miliary tuberculosis or pneumoconiosis.

HENRY K. TAYLOR, M.D.

Idiopathic Pulmonary Hemosiderosis (Essential Brown Induration). Per Selander. Acta paediat. **31:** 286–299, March 25, 1944. (In German.)

A case of idiopathic pulmonary hemosiderosis coming to autopsy is recorded. The patient was a girl of eight with a history of respiratory difficulty from birth. Following an attack of whooping cough early in 1941, at the age of seven, the patient continued to cough for some time. Toward the end of the year dyspnea became more severe, anemia developed, and blood-streaked sputum was observed. Roentgen examination showed silicosis-like changes in the lungs. Death occurred a year after the exacerbation of symptoms. Roentgenograms and photomicrographs show the iron deposits in the lungs and hilar lymph nodes. No iron deposits were present in the liver or spleen.

Spontaneous Mediastinal Emphysema. Samuel A. Shelburne. U. S. Nav. M. Bull. **44:** 610–613, March 1945.

Mediastinal emphysema may appear suddenly without previous injury, accompanied by severe pain over

the heart and sternum, with crackling, bubbling and crunching sounds over the heart, which may be mistaken for a pericardial or pleural friction rub. The author describes two cases and calls attention to the x-ray sign of a sharp line around the borders of the heart which disappears on subsequent films.

BERNARD S. KALAYJIAN, M.D.

Multiple Congenital Arteriovenous Aneurysms in the Pulmonary Circulation. John H. Sisson, George E. Murphy, and Elliot V. Newman. Bull. Johns Hopkins Hosp. **76:** 93–111, March 1945.

A case of multiple congenital arteriovenous aneurysms in the pulmonary circulation in a 45-year-old colored woman is presented. Six months before admission to the hospital the patient had a sudden attack of sharp, non-radiating epigastric pain, with shortness of breath. Three similar attacks followed at fortnightly intervals. A fifth attack occurred a month before admission, with severe dyspnea, dizziness, and nausea. The nausea continued, with daily vomiting, until admission. The ankles were edematous. Four days prior to entry the patient coughed up a small amount of bright red blood and complained of a transient numbness in her left arm and shoulder, with paralysis of the left thumb and index finger. She had lost 35 pounds in the last four months.

Examination showed cyanosis, clubbing of the fingers, hemangiomata, and a bruit over the chest. A postero-anterior film of the chest revealed an enlarged left ventricle and a round opaque area with well defined sharp borders to the left of the left ventricle. The lungs were otherwise clear. Fluoroscopy showed a normal aortic knob and pulmonary conus. The right auricle pulsated vigorously. The mass described above shifted up and down with the respiratory movements. It was not attached to the heart and showed no marked pulsation. It was best seen in the left anterior oblique position, lateral to the left ventricle. Bronchograms revealed no communication between the mass and the bronchi.

The patient was tested for sensitivity to diodrast by giving 10 c.c. of a 35 per cent solution intravenously and had no reaction. Seven days later a nylon catheter was inserted into the right auricle *via* the cubital, axillary, subclavian, and innominate veins, and superior vena cava, according to the technic of Cournand, and 35 c.c. of 70 per cent diodrast was introduced directly into the right auricle *via* the catheter in two seconds. Four pictures were taken in the next thirteen seconds. Although the patient had received luminal (128 mg.) and morphine sulfate (10 mg.) intramuscularly an hour before, she was quite apprehensive after the procedure was completed. She had severe asthmatic respirations with quick inspiration and noisy difficult expiration, and commented that she felt she was going to have an attack similar to to those described in the present illness. Profuse perspiration developed and asthmatic wheezes were audible at both lung bases. Aminophylline was given intravenously. Coarse râles spread throughout both lungs, pink frothy sputum flowed from the mouth, and despite the immediate use of oxygen, intracardiac adrenalin, tourniquets, and artificial respiration, the patient died twenty-five minutes after the injection of the dye. The exact cause of death could not be accurately determined.

The autopsy findings are given in detail and the case is compared with 5 cases previously reported as cavernous hemangioma or arteriovenous fistula of the lung. It is concluded that multiple congenital arteriovenous aneurysms should be suspected when one finds clubbing cyanosis, dizziness, dyspnea, fatigue, polycythemia, and roentgenographic evidence of unusual pulmonary opacity.

The authors believe that the intravenous use of diodrast should be approached with caution in patients with hypertensive cardiorenal disease and analyze 12 previously reported cases of death following within one hour the intravenous injection of diodrast in diagnostic procedures.

Chronic Stridor in Early Life Due to Persistent Right Aortic Arch. Report of Two Cases. Harold K. Faber, John W. Hope, and Francis L. Robinson. J. Pediat. **26:** 128–137, February 1945.

Two cases of persistent right aortic arch in infants are reported, bringing the total number of cases diagnosed during life to 6.

Difficulty in swallowing is common in patients with persistent right aortic arch and was present in both of the authors' cases. More conspicuous in children is noisy breathing, accentuated during exertion or feeding and at times severe enough to cause retraction of the suprasternal notch, rib cage, and epigastrium, cyanosis, and even extreme extension of the head. During sleep the stridor tends to diminish or disappear. Respiratory infections are likely to cause exacerbations of the obstructive symptoms.

Diagnosis of this condition during life is entirely dependent upon roentgen examination but, since special technics are necessary, the anomaly will almost certainly be missed unless the clinician or radiologist looks specifically for it. It must be differentiated from mediastinal tumor, aneurysm of the aorta and, especially in infants, enlargement of the thymus. Barium in the esophagus is essential to diagnosis. The most characteristic roentgen features are the anterior displacement of the esophagus at the level of the bifurcation of the trachea (lateral view) and a rounded filling defect of the esophagus which, in the anterior view, is displaced to the left. The knob of the right aorta can be seen behind the esophagus as a round mass, while the normal left aortic knob is absent. In the anterior view, in some cases at least, the right aortic arch stands out boldly at the right of the vertebral column above the heart shadow as a rounded prominence, which might easily be mistaken for the enlarged right lobe of the thymus. Arkin (Am. Heart J. **11:** 444, 1936) points out the value of the right anterior oblique view, which best brings out the position of the aorta behind the esophagus, the forward displacement of the esophagus and trachea, and the appearance of the aortic knob under the sternal end of the right clavicle, separated from the heart shadow by a characteristic light band representing the trachea and right main bronchus. Careful fluoroscopic examination will usually reveal pulsation of the prominence in the right upper mediastinal shadow and at the margins of the filling defect in the esophagus. A pulsation may also be seen by bronchoscopy or esophagoscopy and may be demonstrated by kymograms, or by angiograms with opaque substances in the blood stream. The latter method is, however, too cumbersome and uncertain to be of much practical value. Kymography, according to the method of Arana and Aguirre (Arch. argent. de pediat. **11:** 331, 1940) should be employed routinely in all suspicious cases. In double aortic arch, with total persistence of the left

arch, the esophagus is not pushed to the left but is uniformly constricted.

In congenital or chronic stridor not due to obvious causes, persistent right aortic arch should always be considered. The diagnosis of enlarged thymus and "thymic stridor," based on a broad shadow in the upper mediastinum, should not be accepted until a persistent right arch has been excluded.

An Evaluation of Teleroentgenographic Mensuration and Cardiac Roentgenoscopy in the Diagnosis of Early Mitral Valve Disease. Bernard S. Epstein. Am. J. Roentgenol. **53:** 259–269, March 1945.

The first recognizable change in the size of the heart due to mitral valve disease is enlargement of the left auricle, which may occur before the other chambers are affected. Teleroentgenographic mensuration, which is the most frequently used procedure for determining cardiac enlargement, does not take into consideration the fact that posterior enlargement of the left auricle may occur without altering the frontal silhouette of the heart.

The author reports a study of 40 patients with early but indisputable mitral valve disease. Each patient was examined roentgenoscopically, by means of postero-anterior teleroentgenograms and right anterior oblique views made after swallowing a bolus of barium paste. The normal right anterior oblique roentgenogram of the esophagus presents a straight opaque line posterior to the cardiac shadow. Early left auricular enlargement usually results in an indentation into the anterior aspect of the barium column at the proper level. This indentation persists during deep inspiration.

Twenty-one patients had known histories of rheumatic fever and 7 had histories which were suspicious of rheumatic fever. In four patients there was recession of the murmurs so that at one time or another the clinical diagnosis had been changed to functional heart murmurs. There is little doubt that the mitral lesions in these individuals were persistent even though the clinical signs varied. All 40 patients had visibly enlarged left auricles as indicated by posterior deviation of the barium-filled esophagus in the right anterior oblique projection. There were no other signs of left auricular dilatation. Straightening of the second left cardiac border occurred occasionally, but the characteristic "mitral heart" deformity was conspicuous by its absence.

It is concluded that if teleroentgenograms alone are used for roentgen examination in doubtful cases, avoidable errors may occur. Prediction tables based on height and weight, the ratio of the heart rectangle to the lung rectangle, and the relationship of the apex to the left midclavicular line did not prove reliable in the diagnosis of early mitral valve disease in this group of patients. Mitral valve disease may exist for a long time without increase in the size of the heart other than left auricular dilatation.

CLARENCE E. WEAVER, M.D.

THE DIGESTIVE SYSTEM

Gastrointestinal Disorders Simulating Circulatory Disease and Vice Versa. Franz M. Groedel. Am J. Digest. Dis. **12:** 73–79, March 1945.

In the diagnosis of cardiac and gastro-intestinal disorders the origin of certain pathologic signs, particularly pain sensations, is often difficult to determine. It is dangerous to make a diagnosis by hard and fast rules without taking account of the variations that may occur because (1) both regions may be diseased simultaneously, (2) gastro-intestinal disease may simulate heart disease and vice versa, (3) a disease of the circulatory system may be concealed by the gastro-intestinal symptoms.

The author does not feel that the incidence of gastro-intestinal disease is higher in cardiac cases than among other patients. He believes that if, for example, coronary thrombosis and gastro-intestinal ulceration occur simultaneously, the underlying cause may be the same, a disturbance of the autonomic nervous system that may result in poor blood supply, which in turn may cause organic disturbance.

Because there are paths of reflex radiation between abdominal and circulatory systems, all cardiac symptoms can be caused or simulated by gastro-intestinal disease and many gastro-intestinal and liver disorders may simulate cardiac lesions. Frequently it is necessary to x-ray the gastro-intestinal tract to rule out its involvement.

A number of case histories are given illustrating conditions where the differential diagnosis between cardiac and gastro-intestinal disease was made only after extensive study. JOSEPH T. DANZER, M.D.

Gastric and Duodenal Ulcers in Infancy and in Childhood. Edward J. Donovan and Thomas V. Santulli. Am. J. Dis. Child. **69:** 176–179, March 1945.

Ten cases of gastric and duodenal ulcer in infants and in children under thirteen years of age, encountered at the Babies Hospital, New York, from 1930 to 1944, are reviewed. Although gastric and duodenal ulceration is rare in infancy and childhood, the diagnosis would probably be made more frequently if it were realized that the condition does occur in this age group. Peptic ulcer should be suspected in all cases of indefinite abdominal pain in children, particularly if the pain is epigastric. Roentgenologic studies may reveal the lesion, but it is not so easily demonstrated as in adults. Hemorrhage is the most common complication, occurring in 6 of the 10 cases reported. Perforation and pyloric stenosis were also observed.

Gastric Schwannoma: Report of a Large Intragastric Lesion Simulating a Bezoar. Julio Sanguily and Francisco Leon Blanco. Surgery **17:** 328–336, March 1945.

The type of tumor here described is known in the medical literature by many names following the different microscopic aspects which it may present and the different conceptions of its nature. Penfield, considering it of connective-tissue origin, calls it perineural fibroblastoma; Verocay designates it neurinoma; the type due to Schwann's cells is called schwannoma or lemmoma; others consider it a peripheric glioma.

The authors' patient was a 58-year-old Negro woman with digestive complaints and a mobile epigastric mass. Roentgen examination demonstrated a foreign body occupying the whole gastric cavity, resembling a bezoar, and exploration was undertaken. This revealed a large solid tumor occupying the entire gastric cavity and attached by a pedicle to the posterior wall of the fundus. The tumor had assumed the shape of the stomach. Operative removal was successful and a histologic diagnosis of schwannoma was made.

J. E. WHITELEATHER, M.D.

Roentgenologic Examination of the Stomach with Patient Under Sodium Pentothal Anesthesia. H. E. Plenge and J. N. Ross. Southern M. J. **38:** 183–185, March 1945.

Three cases came to the authors' attention, in which a constant deformity of the pylorus, as shown on the roentgenogram, led to a diagnosis of cancer, but no lesion was found at operation. Apparently in each instance the stomach had been subject to continuous spastic deformity which disappeared following the induction of anesthesia.

The authors' own case is that of a 54-year-old man who had persistent epigastric distress and occasional vomiting. Roentgen study showed an apparently massive fixed lesion of the pylorus with a large crater on the lesser curvature. A subsequent examination, following administration of belladonna, produced an identical picture. A third roentgen examination, carried out quickly under anesthesia produced by a small intravenous dose of "sodium pentothal," revealed relaxation of a previously narrowed portion of the original deformity, which apparently resulted from spasm. The procedure is advocated as a simple measure in certain doubtful cases, in which it may prevent unnecessary surgery.

MAX MASS, M.D.

Orientation of the Gastroscope by Roentgenograms. A. Ray Hufford and G. G. Stonehouse. Am. J. Digest. Dis. **12:** 61–64, March 1945.

In order to show what actually happens to the gastroscope and to anatomical structures through which it passes, the authors made a radiographic study of two patients during gastroscopy. In neither was there any roentgen or gastroscopic evidence of disease of the esophagus, stomach, or duodenum. The position of the gastroscope was visualized by impregnating its rubber tip with sufficient barium to make it densely radiopaque.

The greatest degree of flexion of the gastroscope occurred in the lower end of the esophagus, where the tip flexed acutely to the left and forward as it passed into the cardia. The normal angulation of the esophagus was almost completely eradicated by the flexible shaft of the gastroscope, but in compensation the shaft was flexed about five degrees. After the scope passed the cardia, air was injected and the tube passed down to the lower end of the stomach, where the tip flexed at an acute angle to conform with the contour at the greater curvature. The blind spots or areas in the gastric wall were shown to be those parts which are in contact with or short of the focusing distance from the objective or inclined away from the objective at such an oblique angle that only a darkened area can be seen.

A study of the x-rays taken convinced the authors that the gastroscope is sufficiently flexible to pass through normal channels without any undue stress or strain on them. The tip can be passed by sight until it rests in the lower pole of the stomach, which adjusts itself to the slightest pressure of the scope.

JOSEPH T. DANZER, M.D.

The Gall Bladder in Patients with Pernicious Anemia: A Study of Non-Visualization and Rate of Emptying. Edward A. Boyden and John A. Layne. Gastroenterology **4:** 121–134, February 1945.

Cholecystographic studies were made of 48 unselected patients with pernicious anemia (23 males and 25 females) seen in the University of Minnesota Hospitals. All but 2 of the patients were receiving treatment with liver extract at the time of the study, and the hemoglobin and erythrocyte levels had either reached normal or were responding to treatment. Examination of the gastric contents, following subcutaneous administration of histamine phosphate, showed complete absence of free hydrochloric acid in all cases, and only minimal amounts of total acids.

The following technic was employed. On the evening preceding examination, "isoiodeikon," in a sterile solution of physiological saline, was injected intravenously —40 mg. per kg. of body weight—the maximum dose for any one patient being 2.5 gm. Subsequent to the demonstration of the gallbladder shadow, films were taken at 0, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, and 45 minutes after the fat meal. The outlines of the gallbladder were then transferred to tracing paper and divided into segments representing circular plinths. From these, the changing volumes of the gallbladder were computed.

In 8 of the 23 males (35 per cent) and in 12 of the 25 females (48 per cent) no gallbladder shadow was demonstrable. In the male patients in whom the shadow was demonstrated, the curve of evacuation was not significantly different from that of the controls. In the women, there was a highly significant retardation, only 65 per cent of the gallbladder contents having been discharged in the first forty minutes after the standard fat meal as against 84 per cent in the controls. Most of the women in this series had borne children. The greater susceptibility of the female group of patients may be attributed to the double insult sustained by the gallbladder—the stasis induced by pregnancy and the superimposed stasis induced by pernicious anemia. Twenty-seven per cent of the entire group from which curves of evacuation were obtained showed a reflux of cystic bile into the common hepatic duct. This indicates that in some cases there is a permanent narrowing of the choledochoduodenal junction, independent of the condition of the gallbladder wall.

An analysis of the 105 cases of pernicious anemia in 31,311 consecutive necropsies at the University of Minnesota Hospitals revealed that 32 per cent of the group had had cholecystitis or cholelithiasis (or both), or the gallbladder had been removed. This study showed an increasing incidence of gallbladder disease with age, ranging from 16 per cent in the fifth decade to 50 per cent in the eighth. In the authors' group a similar progression occurs. Since the greatest incidence in the general population is in the fifth decade, these observations suggest that pernicious anemia and gallbladder disease have an etiological relationship.

Since all but two of the patients had been given liver extract before the cholecystographic studies, no correlation could be shown between the visualized and nonvisualized groups either in respect to duration of the pernicious anemia, duration of treatment, or response to treatment. It is suggested that damage to the biliary duct system occurs in the early stages of anemia.

The occurrence of a normal rate of emptying of the gallbladder in the males in whom the organ was visualized, notwithstanding the complete absence of free acid in the stomach, indicates that free hydrochloric acid is not essential to evacuation of the biliary vesicle.

Aberrant Pancreatic Tissue as a Roentgenologic Problem. George J. Baylin. Am. J. Roentgenol. **53:** 277–280, March 1945.

The close embryological relationship of the duodenum and pancreas, with the latter originating as buds

from the former, makes it easy to understand why there are small clumps of pancreatic tissue frequently embedded in the duodenum and other portions of the intestinal tract. Two cases are described. In one there was an ampullary defect in the duodenum which was diagnosed roentgenologically as a carcinoma. The patient was jaundiced. At operation a cluster of aberrant pancreatic tissue was found near the papilla. This was not causing obstruction and there was no lesion in the head of the pancreas. At autopsy, an extensive inflammatory process of the liver was found which accounted for the obstructive jaundice. The other patient had an annular constriction of the second portion of the duodenum. This was correctly diagnosed as circular constriction of the duodenum by aberrant pancreatic tissue. In every instance of a persistent narrowing in the size of the lumen of the second portion of the duodenum the diagnosis of aberrant pancreatic tissue must be considered. This may produce obstructive symptoms in the presence of pancreatitis.

CLARENCE E. WEAVER, M.D.

THE ADRENALS

Hormonal Tumors of the Adrenal. George F. Cahill. Surgery **16:** 233–265, August 1944.

This comprehensive discussion of adrenal tumors opens with a review of the development of the adrenals. It is well established that these glands elaborate androgens and estrogens, as well as other metabolic hormonal steroids, and that these hormones may be present in excess amounts in tumors of the adrenal cortex. The symptoms of such tumors vary according to the hormone secreted, its amount, and the age and sex of the patient. The following clinical classification is repeated from an earlier paper (Cahill, Melicow, and Darby: Surg., Gynec. & Obst. **74:** 281, 1942).

1. No recognizable hormonal change.
2. Changes due to excess androgens.
   (*a*) In female child toward adult masculinity.
   (*b*) In female adult toward masculinity.
   (*c*) In male child toward adult masculinity.
3. Changes due to excess estrogens.
   (*a*) In adult male toward feminity.
4. Changes due to excess androgens and other steroids.
   (*a*) Cushing's syndrome with associated sexual changes (mostly in females).
5. Changes due to excess of other steroids related to metabolism.
   (*a*) Cushing's syndrome without sexual changes (in male and female).

Each of these groups except the first is taken up in detail, with references to the literature and to cases recorded in the paper cited above.

Syndromes suggestive of adrenal changes are only in rare instances of neoplastic origin. Once the presence of high levels of androgens or estrogens in the urine has been established, x-ray studies with the aid of air insufflation into the perirenal fascial spaces will determine the presence or absence of a tumor. [See the author's paper on this subject in Radiology **37:** 533, 1941.] The tumors are round when small, ovoid when larger, and may be lobulated when very large. Air insufflation is of special value when the tumor is small and unrecognizable by any other method except operation.

The sole hormone-producing tumor of the adrenal medulla is the pheochromocytoma, known also as paraganglioma and chromaffinoma. The only known secretion of the pheochrome cell is epinephrine, and the symptoms of pheochromocytoma are those of paroxysmal hypertension, due to excess pressor substance in the blood. The diagnosis of these medullary tumors depends upon the characteristic hypertensive attacks, the demonstration of the pressor substance in the blood, and air insufflation studies.

The author describes the therapeutic management of both cortical and medullary adrenal tumors. Removal of cortical adenomas produces a cure, though fixed changes may persist. Even if the tumor proves to be a carcinoma, some amelioration of symptoms may follow operation. Acute adrenal deficiency incident to removal is to be treated like the acute crises of Addison's disease, with potent adrenal hormone. Medullary tumors are for the most part benign, and if the patient survives the operation and immediate postoperative period, the prognosis following removal is favorable. The collapse subsequent to operation may be combated by adrenalin, adrenal cortical hormone, or intravenous saline. Nine cases of pheochromocytoma are briefly reported.

J. E. WHITELEATHER, M.D.

THE MUSCULOSKELETAL SYSTEM

Bone Regeneration Following Osteomyelitis. Laurence H. Mayers. Surgery **17:** 463–471, March 1945.

The processes of bone destruction and bone restoration in an osteomyelitis of the phalanges of a finger go on almost simultaneously. An illustrative case is reported, in a policeman who was bitten on the middle finger of the left hand. Pyogenic organisms, spirilla, and anaerobes were all present as the case progressed. Although the patient was forty years old, far beyond the age at which bone restoration is regarded as assured, the amount of regeneration is surprising and interesting.

The day after the wound was received, the finger was incised below the nail, liberating a quantity of foul, purulent material. The early film showed very little destructive change, but six days later a definite osteomyelitic process with rapid extension was apparent. Twelve days later there was almost complete dissolution of the middle portion of the phalanx with moderately advanced invasion of the distal three-fourths of the middle phalanx and involvement of the distal joint.

The treatment covered the conventional range. Sequestration was observed twenty-two days after the injury and indicated the first effort at restoration of the destroyed bone. Four days later there was further invasion toward the middle joint with increasing destruction of the distal phalangeal bone; sequestrated fragments of bone were visible as evidence of the conflict between living and dead cells. In another seven days films showed progression of the osteomyelitis but diminution of the edema. Five weeks after the wound was received the finger was reoperated upon. A small amount of necrotic tissue was removed, and the flexor tendon was exposed and found to be destroyed distal to the proximal and middle phalanx. Three weeks later improvement in the bone of the distal phalanx was evident roentgenographically, although there was some further invasion of the middle and proximal phalanges and the periosteum was stripped in the middle portion. Eventually the osteomyelitic process abated and the cortex reappeared.

A series of x-ray films is reproduced permitting one to

trace the course of this virulent infection, resulting in a destructive and progressive osteomyelitis, from the beginning to the final climax of bone restoration.

J. E. WHITELEATHER, M.D.

Solitary Eosinophilic Granuloma of Bone. Benjamin B. Greenberg and Albert J. Schein. Am. J. Surg. **67:** 547–555, March 1945.

Two new cases of solitary eosinophilic granuloma, one involving the clavicle and the other the tibia, are presented. Neither case was diagnosed preoperatively. In the one case, roentgen studies showed an irregular expansion of the shaft of the lateral third of the clavicle. Bony trabeculae extended throughout a bony defect in the expanded area. The lesion was about 5 cm. long. At several points, the cortex had been completely eroded. There was a moderate amount of periosteal new bone formation extending mesially from the bony lesion along the shaft of the clavicle. A tentative diagnosis of primary bone tumor was made, with the most likely possibilities giant-cell tumor, chondroma, and chondrosarcoma. In the second case, x-ray examination showed a destructive lesion involving the proximal third of the shaft of the tibia. The lesion had eroded the anterior cortex and invaded the medullary cavity as far as the endosteal zone of the posterior cortex. It had also extended laterally in either direction. It had produced a periosteal reaction mostly on its medial but also in its anterolateral aspect. The destructive zone extended almost to the epiphyseal line in the diaphysis and was eccentrically placed. The original tibia outline showed no expansion. Diagnostic suggestions were Ewing's tumor and osteomyelitis. The diagnosis of eosinophilic granuloma in each case was made only on pathologic study of excised material. Roentgen therapy, in small doses, was administered postoperatively in both instances. Both patients were well at the time of the report.

Although pathological examination is essential for the diagnosis of doubtful or obscure bone lesions, the authors believe that x-ray films may suggest eosinophilic granuloma before biopsy if the lesion is borne in mind.

Roentgen Diagnosis of Traumatic Lesions of the Cervical Spine. Gilbert W. Heublein. J. A. M. A. **126:** 950–954, Dec. 9, 1944.

Basing his presentation upon experience gained in a large Army General Hospital, the author discusses the importance of roentgenologic methods in dealing with cervical spine injuries. Concise case reports are used to illustrate various points.

Among the confusing shadows which may at times mimic fractures of the cervical spine are extra ossification centers, areas of incomplete fusion, superimposed teeth shadows, sesamoids in the ligamentum nuchae, and limbus vertebrae. Fractures at the base of the odontoid process may not be evident on initial examination, but may show up weeks later as rarefying osteitis along the fracture line. Pathologic fractures in the cervical spine are rare. Rotary dislocation of the atlas on the axis may be the result of structural weakness, uncomplicated trauma, or an inflammatory process in adjacent cervical soft tissues.

Technic is extremely important. The conventional anteroposterior and lateral projections should be supplemented at times with open-mouth views, the Jackson projection, lateral films made in flexion and extension, laminagraphy, and myelography.

It is emphasized that the success of myelography depends upon employing proper apparatus, accurate spinal puncture by an experienced neurosurgeon, adequate extension of the neck, post-myelographic withdrawal of the opaque medium and, finally, careful correlation of clinical and roentgenologic findings.

JOHN F. HOLT, M.D.
(University of Michigan)

Cleidocranial Dysostosis—Report of Case. Fred G. Repass. Virginia M. Monthly **72:** 121–124, March 1945.

A case of cleidocranial dysostosis is presented with special reference to the dental aspects. A woman of twenty-nine was referred by her dentist to the author, a dental surgeon, for removal of the teeth, including several which were unerupted and impacted. She had been wearing an upper denture for fifteen years and a partial lower denture for ten, because so few permanent teeth had ever erupted.

The patient was small of stature (49 inches) and gracefully built, as are most of those with this condition. There was moderate bulging of the forehead with prominent bosses. The maxilla was small and underdeveloped with a high furrowed V-shaped palate. The lower jaw was prognathous.

Dental films revealed twenty-six unerupted and impacted teeth lying in irregular arrangement. In the upper and lower anterior regions these appeared to be in clusters, some being inverted. Roentgen examination of the skeleton showed absence of the left clavicle, except for a small stump 2.5 cm. in length at the sternal end; the two ends of the right clavicle had never fused. There was a spina bifida occulta of the first and second dorsal vertebrae. The skull was brachycephalic with a prominent lower jaw, the frontal sinuses were small and the mastoids undeveloped. Numerous small wormian bones appeared along the suture lines, and a metopic suture in the frontal bone.

The patient's mother showed a similar condition, a sister was normal, and a 3-year-old son as yet showed no evidence of the disease.

In a discussion of the dental problems involved in these cases, the author states that extraction of the deciduous teeth does not aid in the eruption of the permanent teeth and is contraindicated; instead, the deciduous teeth should be given the utmost care. If they are lost, they should be replaced by prosthetic appliances even though the edentulous areas contain many unerupted teeth. The removal of an occasional unerupted tooth may be necessary. Orthodontic treatment appears to be of no avail; occasionally bilateral osteotomy may have to be performed to correct the prognathous condition of the lower jaw.

J. E. WHITELEATHER, M.D.

A Case of the Klippel-Feil Syndrome (Congenital Synostosis of the Cervical Vertebrae). Roald Rinvik. Acta paediat. **31:** 417–427, June 30, 1944. (In English.)

A case of synostosis of the cervical vertebrae associated with spina bifida in a young child is reported. An unusual feature of the case was an extensive occipital spina bifida. Roentgen examination revealed a cleft in the pelvis of the right kidney, but no evidence of a double ureter could be found. Certain peculiar subcutaneous alterations of the chin and fingers were also present.

Spondylolisthesis: A Commentary on Etiology, and an Improved Method of Roentgenographic Mensuration and Detection of Instability. Isadore Meschan. Am. J. Roentgenol. **53:** 230–243, March 1945.

The essential underlying predisposing factor in spondylolisthesis is the bilateral defect in the pars interarticularis of the neural arch. This is thought to be due to a failure in ossification similar to that found in spina bifida. There are some who favor a completely traumatic origin for the disease. It is believed the trauma may occur very early in life—during delivery or early in the post-natal period. Whether or not the original defect is developmental or traumatic, there is evidence that trauma, even of minor degree, may widen the defect, initiate symptoms, and even start the displacement. In the rigorous training of soldiers, the development of spondylolisthesis is a definite possibility. The disease cannot be dismissed lightly as a congenital anomaly.

For mensuration of spondylolisthesis the author draws lines on the lateral roentgenogram as follows: (1) from the posterior lower lip of the vertebral body above the one involved, to the posterior upper lip of the body below; (2) between the posterior upper and lower lips of the slipped vertebral body. The lines are extended, if they are not parallel, so that they meet and form a measurable angle. The apex of the angle always falls above the body in question. If the lines should be parallel, the distance between them is 4 mm. or more. Angles up to 10 degrees can be called slight, 11 to 20 degrees moderate, and greater than 20 degrees severe. The displacement of the vertebral body is seldom linear. This method also furnishes a means of measuring accurately any change which occurs in weight bearing, flexion, and extension by comparison of the measured angle on roentgenograms made under these conditions.

In an Army General Hospital 57 cases of defect of the pars interarticularis (5.1 per cent) were found in a total of 1,131 lumbosacral spine examinations; 41 showed spondylolisthesis, in 37 cases involving the fifth lumbar vertebral body.

The displaced vertebral body may or may not be stable. In 7 of the 41 cases of spondylolisthesis in the present series it was found to be unstable; in 4 of these this could be demonstrated by comparison of the recumbent with the weight-bearing (standing) neutral roentgenogram; 3 cases revealed instability only after a roentgenogram in hyperextension was compared with the other views. The value of the oblique roentgenogram of the lumbosacral spine for demonstration of defects of the pars interarticularis is emphasized.

CLARENCE E. WEAVER, M.D.

Isthmus Defects of the Fifth Lumbar Vertebra. R. Beverly Raney. Southern M. J. **38:** 166–174, March 1945.

The condition designated variously as bilateral isthmus defect (*i.e.*, lack of bony continuity in the pars interarticularis), prespondylolisthesis, spondylolysis, and spondyloschisis is believed to be responsible for many cases of low-back pain even in the absence of vertebral displacement. The defect divides the vertebra into two separate parts and leaves the stability of the spine dependent solely upon the supporting ligaments.

The incidence of isthmus defects (bilateral and unilateral), as based on an anatomical study of over a thousand skeletons, is in the neighborhood of 5 per cent. Figures based on roentgen studies vary. The author found defects demonstrable in the oblique roentgenogram in 94 of 300 patients (*i.e.*, 31 per cent) examined because of low-back pain. In about 70 per cent the defect was bilateral. The fifth lumbar vertebra was involved in 92 patients (97 per cent of the positive cases). In 2 cases the fourth lumbar vertebra was also affected and in 2 cases it alone was involved.

The author presents the pathologist's report on a part of a defective isthmus removed for biopsy from one of his patients. The opposing margins were made up of compact bone covered with hyaline cartilage, while fibrillar connective tissue containing few cartilage cells completely bridged the gap.

The preponderance of opinion seems to indicate that these defects are probably a developmental anomaly; however, some believe they may be due to birth trauma. Symptoms are predominantly low-back pain aggravated by increased mechanical stress and relieved by immobilization, radiating pain along nerve distribution in the lower extremities, and limitation of motion and tenderness in the back muscles. The diagnosis is almost entirely dependent on a careful roentgenographic study.

The oblique projection taken with the patient supine, but with one side of the body so raised that its transverse axis lies at an angle of approximately 45° to the table and film, demonstrated, every case in this series. Only 18 per cent of the positive cases could be demonstrated in the anterior view and only 20 per cent in the lateral view.

Conservative treatment is advised, consisting of splinting and immobilization. When these measures are ineffective, lumbosacral spinal fusion is indicated.

In the discussion of this paper, Dickson, of Kansas City, stated that 70 per cent of cases of low back pain treated surgically in his clinic were due to instability of the lumbosacral region and 30 per cent to protruded disks. Sixty per cent of the cases of faulty architecture were due to isthmus defects. Dr. Dickson places greatest reliance on the lateral roentgenogram taken in acute flexion and extension, Dr. McCarroll of St. Louis stated that all isthmus defects coming to operation should also be explored for possible disk protrusion. Many roentgenographic illustrations are included. A bibliography is appended. MAX MASS, M.D.

Calcification of the Intervertebral Discs in Childhood. H. Stephen Weens. J. Pediat. **26:** 178–188, February 1945.

A 5-year-old girl was admitted to the hospital with severe pain in the back of the neck. This acute episode was preceded by slight aching in the back of the neck of two months' duration. The patient had had frequent attacks of tonsillitis, otitis media, and ascariasis. Her temperature on admission was 100° F. Physical examination showed a rather conspicuous hyperextension of the neck. Slight passive rotation of the head was possible, but flexion could not be carried out. The child walked with stooped shoulders and marked kyphosis of the dorsal spine. The temperature returned to normal in two days, without treatment. Two days later all pain had disappeared and the patient was discharged twelve days after admission free of symptoms. There was no residual deformity of the spine, and movement of the head and neck was not restricted.

Roentgen studies, including fluoroscopy, at the time of admission revealed a dense, flocculent, cone-shaped

area of calcification, measuring 6 × 5 × 2 mm. in diameter, in the space between the sixth and seventh cervical vertebrae, extending from the anterior portion of the intervertebral disk into its mid-portion. The cervical spine was hyperextended, and no narrowing of the intervertebral spaces or bone destruction was demonstrated. The retrotracheal soft tissues were not swollen, and the esophagus, on examination with barium, appeared normal. Review of a chest film taken several months previously showed the calcification, possibly somewhat larger at that time. On the patient's discharge it had decreased further in size, only a small calcium deposit, measuring not more than 1 mm. in diameter, being demonstrable in the region of the anterior portion of the disk. X-ray studies after four months showed complete disappearance of the calcification.

Five cases of calcification of the intervertebral disks involving the nucleus pulposus in childhood are abstracted from the literature. Like the author's case, these were all characterized by an acute episode of pain in the region of the involved segment of the spine, limitation of motion, and spinal deformity. Signs and symptoms of infection were present in most of the cases and suggest that an inflammatory process was associated with the calcification. The fact that the intervertebral disks in childhood possess a blood supply may be important in this connection. An aseptic necrotic process as a possible cause of the calcification is mentioned. In all 6 of the cases there was complete recovery.

Certain differences between calcification of the intervertebral disks in the child and in the adult are suggested:

1. Involvement of the cervical spine was present in 4 of the 6 cases occurring in childhood, while calcification of the nucleus pulposus in the adult is localized predominantly in the dorsal and lumbar regions.

2. Rapid change in the size of the calcification or complete absorption took place in 5 of the 6 cases presented. Calcification of the nucleus pulposus in adult life is, as a rule, stationary.

3. Rather striking clincal symptoms were encountered in the cases in children. In adults calcification of the nucleus pulposus is probably of little clinical significance.

The recognition of this syndrome appears important in the differential diagnosis of meningitis, myositis, and diseases involving the vertebrae or spinal cord.

Pantopaque Myelography as an Aid in the Preoperative Diagnosis of Protruded Intervertebral Discs: Preliminary Report. Francis A. Echlin, Joseph McK. Ivie, and Archie Fine. Surg., Gynec. & Obst. **80:** 257-260, March 1945.

In this paper 36 myelographic studies done with pantopaque on patients with symptoms of herniation of the intervertebral disk are discussed. Of the 36 patients, 20 had defects diagnosed as herniated disk and in 14 instances this diagnosis was verified at operation. The other 6 were not operated upon. In 2 of the 20 cases there was multiple disk protrusion. In 14 cases the myelographic findings were normal and in 2 diffuse intraspinal lesions were demonstrated.

The important points brought out by this paper are several. (1) Pantopaque is far superior to lipiodol both for ease in examination and in removal. (2) Myelography should be done only after a thorough neurological work-up has incriminated the intervertebral disks. It is a difficult and not entirely harmless procedure and should be confined to cases with clinical evidence of a protruded disk. (3) The examination must be done by a physician familiar with the normal and abnormal appearances of pantopaque in the spinal canal. (4) With clinical evidence of herniated disk, operation without myelography is premature, for there may be multiple disks, or intraspinal tumors or diffuse lesions may simulate the clinical picture of herniated disk.

Two cases are reported in which there were multiple defects; "it [the pantopaque] became hung up at different levels in large globules." One of these cases showed diffuse arachnoiditis at operation. [The author's conclusion that surgical intervention was unwarranted in the second case may, in its turn, be unwarranted. In three cases with similar appearance and behavior of the pantopaque column, examined at the Hospital of the University of Pennsylvania, one showed no demonstrable intraspinal lesion, one hypertrophy of the ligamentum flavum with compression of the nerve root, and the third an extramedullary tumor in the upper thoracic region.] J. FRANCIS MAHONEY, M.D.

Low-Back Pain as the Presenting Symptom of Malignant Breast Tumors. T. D. Cohn and H. Cohn. New England J. Med. **232:** 342–343, March 22, 1945.

Reports are presented of 4 cases in which low-back pain was the first and chief complaint of a patient with an undiscovered carcinoma of the breast. In some cases the spine was not examined roentgenographically; in others, roentgen evidence of metastasis could not be found.

The authors stress the findings of Batson, who demonstrated the valveless venous system of the meningoarachnoid system, which communicates freely with the abdominal and thoracic veins and in which blood will flow in either direction. Increased intrathoracic or intra-abdominal pressure will force venous blood into this system of veins.

This presentation again calls attention to the fact that all low-back pains are not due to disk lesions; some are due to metastases that may or may not be demonstrated by x-ray. It is well to examine the breasts of women complaining of low-back pain, before extensive procedures are attempted.

JOHN B. MCANENY, M.D.

Fractures at the Upper End of the Humerus. A Classification Based on the Etiology of the Trauma. Ernst Dehne. Surg. Clin. North America **25:** 28–47, February 1945.

A new classification of fractures at the proximal end of the humerus is proposed, based on the traumatic mechanism producing the fracture. It comprises three main groups termed the lateral, the dorsal, and the central fracture mechanisms. Each group is an entity with distinct clinical properties, characteristic x-ray appearance, specific potential complications, and its own management and prognosis. The same mechanisms that lead to fractures may lead to dislocations as alternative injuries with similar clinical properties.

The *lateral fracture mechanism* may be visualized by abducting the arm until horizontal and pointing the hand straight down, thus placing the humerus in maximum internal rotation. Further elevation of the arm is impossible due to the locking of the greater tuberosity against the upper rim of the glenoid fossa. Depending on the structure that gives way, forceful elevation produces the following injuries:

1. Axillary dislocation through rupture of the inferior part of the joint capsule.

2. Fracture of the greater tuberosity by the shearing effect of the upper rim of the glenoid complicating the dislocation.

3. Fracture of the head plus dislocation because of extreme force.

4. Typical "three-fragment fracture" produced when the capsule does not give way, causing the traumatic force to disengage the shaft away from the head in a curved line of cleavage and the greater tuberosity to be sheared off. These fragments are usually not impacted. Manipulation or the use of an airplane splint tends to shift the fragments out of alignment. Recommended treatment, therefore, consists of adduction and the use of a sling to allow early motion and to permit the weight of the arm to act as its own traction. Complications are usually due to unnecessary manipulation producing uncontrollable rotation of the head and tuberculum. This usually requires open reduction. The tuberculum fragment occasionally invaginates the subdeltoid bursa as it retracts upward and so may not be readily seen at operation.

The anteroposterior projection is adequate to determine the extent of damage and displacement. The lateral view gives no added information and is contraindicated, since the necessary abduction would produce pain and jeopardize the alignment of the fragments.

The *dorsal mechanism* is produced by extending the arm to break a backward fall. The maximum dorsal alevation of the arm is reached when the humerus locks egainst the spine of the scapula at the acromion. Continued force either pushes the head through the joint capsule, dissecting the subscapularis from its scapular attachment, resulting in anterior dislocation, or a fracture occurs, leaving the head in the joint with an upward impaction of the shaft resulting in posterior angulation and producing the "two-fragment fracture."

In this fracture, x-ray examination must include the lateral projection to determine the degree of posterior angulation and the treatment. The impaction permits this view to be made without increase of pain and with little danger of altering the fragment position. Manipulation and traction under anesthesia are indicated to reduce a strongly impacted or markedly angulated fracture and in the rare instance of fracture with complete loss of contact between the head and the shaft. After reduction, a sling or hanging cast is utilized.

The dislocation resulting from the dorsal fracture mechanism, unlike the lateral mechanism dislocation, is usually recurrent. A minor reason for this is that the motion of posterior trauma occurs routinely, as in putting on a heavy coat or by the arm hanging over the edge of the bed while the patient is asleep. The major reason lies in the pathologic structure of the joint following the injury. Investigation showed that the anterior part of the limbus glenoidalis was usually torn loose, hung free, and was dislocated posteriorly; that the anterior rim of the glenoid fossa was rough and denuded of cartilage; and that the subscapularis, deprived of an essential part of its attachment, was thinned out and relaxed. Correction by open reduction is required.

In the *central mechanism*, the head is driven against the glenoid fossa. Injury of the fossa is rare and usually occurs in younger people with strong bone. There is ordinarily complete return of function, with no specific treatment required.

The anteroposterior roentgenogram only is needed in this mechanism. In the so-called "headsplitting fracture," the short horizontal diameter of the glenoid contacts a small sector of the humeral head, giving a characteristic picture. In older people with considerable bone atrophy, the head is shattered into many fragments. This frequently leads to deformity due to destruction of cartilage and resorption of bone.

LESTER M. J. FREEDMAN, M.D.

Conservative Management of Adolescent Slipping of the Capital Femoral Epiphysis. Robert Dunham Moore. Surg., Gynec. & Obst. **80:** 324–332, March 1945.

Forty-four cases in which slipping of the capital femoral epiphysis was treated conservatively are reviewed, with evaluation of the results. The case for conservative management is based on (1) the many unsatisfactory results following currently popular methods of treatment; (2) the belief that the risk of damage to the blood supply of the epiphysis by operation outweighs the disadvantage of the longer disability period necessitated by conservative treatment; (3) the lack of proof that accurate replacement is necessary in cases of moderate deformity, coupled with the difficulty of manipulative replacement when the rate of slippage is slow; (4) the danger of infarction of the epiphysis in operative procedures; (5) the minimum of trauma to the soft parts about the hip as well as the blood supply.

The cases reviewed are divided into three groups showing minimal, moderate, and complete separation, respectively. The results are based on examinations after two to six years.

In Group I, showing minimal displacement, 26 hips were treated by immobilization in plaster with the leg in abduction and internal rotation. This was continued for from three to nine months, until ossification of the capital epiphyseal growth cartilage took place. The results were good in 88.5 per cent, poor in 3.8 per cent, uncertain (no follow-up) in 7.7 per cent.

In Group II, showing moderate displacement, 23 hips were treated by the same general principles, with immobilization for eight weeks to seven months. The results were good in 47.8 per cent, fair in 13 per cent, poor in 21.7 per cent, uncertain in 17.5 per cent.

In Group III, showing complete separation, there were 3 cases. One case, treated by traction and cast, gave good reposition and end-result (33.3 per cent). In the second case traction did not correct the deformity and necrosis of the epiphysis occurred. The third case showed necrosis of the head on admission, and excision of the head and arthrodesis of the hip were done.

Long-term evaluation with reference to traumatic arthritis awaits follow-up studies.

J. L. BOYER, M.D.

Fatigue Fracture of the Fibula. Report on Two Cases. David A. Richmond. Lancet **1:** 273, March 3, 1945.

Two cases of fracture of the fibula are reported, showing all the features described by Blair Hartley (Brit. J. Radiol. **16:** 255, 1943. Abst. in Radiology **43:** 309, 1944) as characteristic of fatigue fractures.

Pathology of the Anomalies Found in Knee Joints. Samuel Harold Nickerson. Am. J. Roentgenol. **53:** 213–229, March 1945.

The embryology of the patella and the literature concerning its phylogenetic development and signifi-

cance in the light of comparative anatomy are reviewed, and the following facts, among others, emerge. The close anatomical relationship between the patella and quadriceps muscle mass has been demonstrated (Walmsley: J. Anat. **74:** 360, 1940). The important dynamic interdependence of the developing patella and quadriceps muscle has been shown experimentally (Carey: Radiology **10:** 234, 1928). The priority of development of the medial components of the knee joint has been embryologically substantiated (Langer: Ztschr. f. d. ges. Anat., Abt. 1, **89:** 83–101, 1929). The embryonic patella develops a larger lateral and smaller medial articular surface. The entire patella is undergoing a slow and gradual development erasure (de Vriese: Anat. Anz., 1908, 32, Erganzungsheft, 163).

Two cases are reported by the author in which there was absence of the medial half of the patella in each knee. The medial synovial compartment was underdeveloped, and there was incomplete vertical septation of the synovial cavity. The first patient also exhibited poor development of the thumb nails. The basic pathology has been described as being due to aberrant or pathological linked genes which possess abnormal mesodermal and ectodermal characteristics. This explains the presence of both ectodermal and mesodermal anomalies in the same individual. The primary developmental aberration due to the pathological gene is manifested by faulty and incomplete differentiation of the premuscle mesenchymal mass which ordinarily is destined to become a portion of the quadriceps extensor apparatus—the vastus internus. The changes occur in the medial portion of the knee joint and exhibit either hypoplastic or aplastic characteristics. The feeling is expressed that the patella in these cases represents the true bone but is the lateral portion only—a hemidevelopment. The medial portion of the knee joint possesses older phylogenetic structures than its lateral portion. Anomalies of the lateral portion will present themselves in the form of accessory growth such as extra-patellar centers. Anomalies of the medial compartment will present themselves in the form of developmental erasure.

CLARENCE E. WEAVER, M.D.

Skeletal Changes in the Acute Leukoses of Children. Olof Brandberg. Acta paediat. **30:** 205–211, Dec. 23, 1942. (In German.)

In 3 cases of acute aleukemic lymphadenosis in children of one, three, and seven years, the following bone changes were observed: (1) small disseminated foci of destruction; (2) periosteal elevation, chiefly along the shafts of the long bones; (3) a "clearing zone"—the zone of diminished density described by Baty and Vogt (Am. J. Roentgenol. **34:** 310, 1935) proximal to the metaphyses of the long bones, adjacent and parallel to the epiphyseal line; a similar zone occurred also along the iliac crest and in the os pubis. The first two changes are due to leukemic infiltration, which, however, is not established in the case of the third.

The author emphasizes the fact that the changes described are not pathognomonic for the leukoses, but they are nevertheless of diagnostic significance.

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography in Sterility. Colin Macdonald. M. J. Australia **1:** 142–144 Feb. 10, 1945.

Investigation of the patency of the fallopian tubes by the injection of lipiodol under fluoroscopic control is valuable both from a diagnostic and therapeutic standpoint. Beneficial results are ascribed to (1) clearing the cervical canal and fallopian tubes of mucus and secretions, (2) relief of spasm, either at the internal os or in the uterus or tubes, (3) breaking down of adhesions on either the mucosal or serous side of the tubes, (4) straightening tubal convolutions and kinks, and (5) preventing adhesions after a plastic operation on the tubes. Macdonald believes that too often Rubin's test suggests tubal obstruction, while lipiodol shows unequivocally that both tubes are patent.

Contraindications to hysterosalpingography include (1) acute or subacute infections in the vulva, the vagina, the cervix, the fallopian tubes, or the pelvis, (2) uterine hemorrhage, (3) suspected pregnancy, (4) fever from any cause, and (5) severe pulmonary or cardiovascular disease. In order to minimize the possibility of oil embolus, many prefer to make the injection between the eighth and twelfth day after a menstrual period, though others hold that better therapeutic results are obtained if the injection is made the day after cessation of menstruation.

Under fluoroscopic guidance the injection proceeds in three stages. When the patient first complains of suprapubic discomfort, it is found that the uterus is filled but that none has passed into the fallopian tubes. Discomfort passes and the injection is continued. When the patient complains of discomfort again, the tubes are outlined to the fimbriated ends. Discomfort again passes and the third and last injection is made. Routinely, films are made at the completion of each stage and at twenty-four hours.

British and American results are in substantial agreement that when cases of sterility were investigated by this procedure 30 per cent of public hospital patients and over 40 per cent of private patients had subsequently conceived and gone to term.

ELLWOOD W. GODFREY, M.D.

Hysterosalpingography as a Diagnostic Aid in Certain Types of Ruptured Uteri. Joseph B. Sheffery. Am. J. Obst. & Gynec. **49:** 423–427, March 1945.

A case of ruptured uterus is reported. The classical signs of sudden pain, shock, and prostration were absent. The patient had been delivered five years before of a viable baby by cesarean section. Her present prenatal course had been uneventful until the beginning of the ninth month. At that time, she complained of severe backache. Four hours later, just prior to hospitalization, the pain subsided. The pulse rate, blood pressure, and respiration were normal. That evening, the patient stated that she no longer felt fetal movements and fetal heart sounds could not be detected. Four days later, roentgenography demonstrated overlapping fetal skull bones. A sterile vaginal examination disclosed a palpable mass, thought to be the uterus, separate from the fetus. Surgery was delayed until hysterography demonstrated the outline of the uterine cavity with dye passing through a tear into the abdominal cavity. Films demonstrating this were made at intervals after the injection of 2.5 c.c., 5 c.c., 7.5 c.c., and 10 c.c., respectively. These are reproduced in the article.

Laparotomy confirmed the diagnosis. A tear was found through the old operative scar in the uterus. The fetus, amniotic sac, and placenta were lying free in the abdominal cavity. Following hysterectomy, the postoperative course was uneventful.

The author feels that such "quiet" cases of ruptured uteri may be more common than realized, and that in many cases death from this cause may have been attributed to "childbirth, postpartum hemorrhage, etc." Hysterosalpingography will aid in clarifying the diagnosis when it would otherwise remain obscure.

STANELY H. MACHT, M.D.

X-ray Studies in Hysterosalpingography, Using a New Cannula. A. P. Hudgins. Am. J. Obst. & Gynec. **49:** 431–435, March 1945.

Hudgins describes his variation of the Colvin screw-type cannula for obturation of the uterine cervix during hysterosalpingography. The modification includes the use of a ball valve and a removable handle so that the cannula, once properly inserted, can be left in place, the handle removed, and the patient allowed up and about with the oil retained by the valve. The cannula is inserted in the cervix under sterile precautions, and about 6 c.c. of iodized oil is injected. The patient is then allowed to walk about for thirty minutes and a radiograph is made at the end of that time. Apparently this is all done without anesthesia or, at the most, with local anesthesia and mild sedation. No mention is made of fluoroscopy. Only one film is taken at the thirty-minute interval and this, according to the author, usually serves the purpose of two or more films necessary by ordinary methods. The theory is that the muscular contractions of the uterus, under the stimulus of distention, will force the oil out through the tubes and into the pelvis. In the thirty-minute period, sufficient contraction is said to occur in most instances to produce this result.

The single film obtained should show filling of the uterine cavity and some oil about the fimbriated ends of the uterine tubes and in the pelvis if the tubes are patent. The author feels that this is a more accurate test than would be obtained by the ordinary method.

In those cases in which the film shows obstruction of the ovarian tubes, he has found that it may be advisable to leave the cannula in place for twelve to twenty-four hours. The rhythmic muscular contractions are kept up during this entire period and there is, he believes, more chance for opening up closed tubes than by repeated injections of oil with pressure maintained at a relatively high level for only a short period of time. No statistics as to the success of the method are given.

There are some apparent advantages in the use of this method of hysterosalpingography, though the abstractor believes that fluoroscopic guidance in the injection of the oil and study of the uterine contractions is of considerable help in making the examination more complete.

BERNARD S. KALAYJIAN, M.D.

THE GENITO-URINARY SYSTEM

Preventive Treatment of Calcium Urolithiasis: Important Role of Early and Frequent Roentgenographic Examinations. R. H. Flocks. J. Urol. **53:** 427–439, March 1945.

Certain conditions are known to predispose to stone formation. This is true where immobilization of the individual takes place, where portions of the urinary tract are paralyzed, and where obstruction and infection of the urinary tract occur as a result of trauma. Though the mechanism of the occurrence of stone in these situations is quite well understood, in spite of meticulous preventive measures, stones may occur. The three fundamental factors are hypercalcinuria, urinary stasis, and urinary infection. Under the conditions of recumbency, hypercalcinuria cannot be prevented. It may be counteracted by maintaining a large urinary output, *i.e.*, dilution of the urine. The preventive treatment of calcium urolithiasis in immobilized patients consists of: (1) maintenance of a large fluid output; (2) control of diet; (3) control of stasis; (4) control of infection; (5) continuation of treatment for three months after immobilization has ceased; (6) frequent roentgenographic check-up examinations. It is the last of these measures that the author emphasizes here.

Prompt diagnosis is important because in their early stages calcium stones are loose masses of small concretions which can in many cases be broken up and washed out, or caused to pass before any extensive damage has occurred and without the need of an open surgical procedure. Several cases are presented to illustrate the importance of thorough and frequent roentgenographic examinations during and after the occurrence of conditions predisposing to calcium urolithiasis.

The method of examination used calls for a plain roentgenogram and another twenty minutes after the intravenous injection of 20 c.c. of diodrast. "This is done one month after the onset of the predisposing condition and then one month, two months, three months, and every six months for one year after the onset of the predisposing condition." If stones or other complications such as urinary infection occur, the examinations are made more frequently.

CHARLES R. PERRYMAN, M.D.

Renal Cyst, Solitary. John W. Martin. J. Kansas M. Soc. **46:** 73–75, March 1945.

The case of solitary renal cyst reported here came to light in the course of an examination occasioned by an industrial accident that was considered to have caused a back injury. In routine x-ray examination of the lumbar spine, a bizarre shadow was observed in the region of the left kidney. Retrograde pyelography showed the left kidney pelvis partially obscured and displaced anteromesially by a large soft-tissue mass containing streaks of calcification, occupying the lower pole of the kidney. The diagnosis of solitary renal cyst was confirmed at operation and subsequent pathologic examination. Questioning of the patient revealed a history of recurrent colds and frequent and urgent desire to urinate, usually in the mornings, for the past eight years. He had also suffered from severe left-sided backache, occasionally requiring bed rest for four or five days, during the past two years.

LESTER M. J. FREEDMAN, M.D.

An Unusual Horseshoe Kidney: Case Report. Henry Bodner and Max K. Moulder. Urol. & Cutan. Rev. **49:** 160–161, March 1945.

A case of horseshoe kidney with three distinctly separated pelves is reported. Retrograde pyelograms revealed a rotated right kidney and a slightly dilated right renal pelvis. On the left, the ureter showed a bifurcation at the level of the fifth lumbar vertebra: one slightly dilated renal pelvis lay in the left paravertebral region, while a second renal pelvis occupied an oblique position across the fourth and fifth lumbar vertebrae. Intravenous pyelography failed to reveal any evidence of the third renal pelvis bridging the lower pole of the two kidneys; apparently, no function was present.

However, moderate pathological changes had occurred in the middle calices and pelvis, as shown in the retrograde pyelograms. MAURICE D. SACHS, M.D.

THE SPINAL CORD

Intraspinal Lipomas. Report of Cases, Review of the Literature, and Clinical and Pathologic Study. George Ehni and J. Grafton Love. Arch. Neurol. & Psychiat. **53:** 1–28, January 1945.

Intraspinal lipomas without associated spina bifida are rare, comprising only about 1 per cent of all intraspinal tumors. Approximately three-fifths of the lipomas are intradural and two-fifths are extradural.

In a lengthy but well written article, Ehni and Love present the many interesting features of these lesions. Illustrative case reports and separate tabulations of previously reported intradural and extradural lipomas supplement descriptions of the clinical, laboratory, anatomic, pathologic, and etiologic aspects of these tumors.

The roentgenologic signs of intraspinal lipoma are not characteristic. One may encounter widening of the neural canal due to thinning of the pedicles and erosion of the backs of the vertebrae, but such abnormality is common in the case of other intraspinal tumors. When the involvement is in the cervicothoracic region and extends over three, four, five or more vertebrae, the possibility of intradural lipoma should be considered. This is particularly true if the changes have been present for several years. It is emphasized, however, that neither age at onset nor duration of symptoms seems to bear any relation to the presence of osseous changes.

Myelography is sometimes helpful in demonstrating partial or complete block in the spinal canal.

JOHN F. HOLT, M.D.
(University of Michigan)

RADIOTHERAPY

Problems of Cancer Biology. R. R. Spencer. J. A. M. A. **127:** 509–514, March 3, 1945.

For years, as chief of the National Cancer Institute, Dr. Spencer has been in close touch with the far-flung activities of the nation's foremost students of neoplasia. From his unique vantage point he has gathered together what may well be considered to be the highlights of the sum of current knowledge bearing on this subject. Giving due credit to advances which have been made in the discovery and the study of carcinogenic agents, he points out that no method has yet been offered for halting or reversing the carcinogenic process once it has begun.

The activities of major cancer research agencies in the United States are listed and the steps are suggested which are calculated to bring nearer a practicable defense against human cancer.

FRED JENNER HODGES, M.D.
(University of Michigan)

Discussion on Post-War Organization for the Treatment of Cancer. E. Rock Carling, George F. Stebbing, John R. Nuttall *et al.* Proc. Roy. Soc. Med. **38:** 147–154, February 1945.

Sir E. Rock Carling states that a number of the schemes sent up for approval of the Ministry of Health under the British Cancer Act are unsatisfactory in that they do not provide for both surgical specialists and radiotherapists working in conjunction. He believes that the organization should be concentrated in a few fully equipped and strongly staffed institutions with a very small group of subcenters. For hospitalization purposes the country outside of London could be divided into about 12 major regions with a university center as its headquarters. Within the "region" would be several subcenters, "districts." At the periphery there should be preliminary investigation centers accessible to patients' homes. Health centers and cottage hospitals could serve this purpose. The headquarters team of specialists should be available for consultation at all levels within the region.

A single radiotherapeutic organization can deal with a population of four million, with a million as a minimum and about two million optimum. The radiotherapist should be consulted in every case. Applications of radium or radon should be done by the specialist within the group best able to apply it in a manner to obtain uniform dosage to the area treated.

Research should play an important part at all levels in the organization. Organized training for all types of technical assistants is a necessity.

The formulation of any cancer scheme should be actuated solely by the interest of the patient. The public should be educated to be satisfied with nothing less than the best available.

Stebbing mentions causes for the unnecessarily high cancer death rate in the United Kingdom. There have been a rapid increase in knowledge and marked development of equipment needed for the early diagnosis of cancer but neither is possessed by a sufficient proportion of practitioners. Under the National Health Service scheme many doctors have to see so many patients that they cannot find time for careful consideration of obscure symptoms. Manifestations of cancer are so diversified that only a team of specialists can deal with the various forms most effectively. Many hospitals have neither an efficient radiotherapy department nor arrangements for obtaining radiotherapy elsewhere.

All services rendered will be part of those provided under the National Service scheme. The facilities of the organization should be available to private patients under suitable financial arrangements. Both "local authority" and voluntary hospitals must take part in the program and some difficulties are expected in obtaining full co-operation.

Stebbing stresses the importance of keeping adequate records and believes that they should be separate from, and in addition to, the regular hospital records.

Nuttall emphasizes the need for radiotherapists to have a good knowledge of surgery and for the surgeons to know the possibilities of radiotherapy in order that the mode of treatment or combination of methods most effective in each case may be used. He believes that radical mastectomy is done too often in "inoperable" cases of breast carcinoma. Block dissection of cervical lymph nodes is a valuable procedure, not done with enough frequency, and too few surgeons are expert at it. Radium and x-ray treatment should be organized as an entity—radiotherapy. All histologic slides should eventually pass through a central pathology unit to provide a wider fund of experience to the pathologist and uniformity of opinion for the clinician.

The advisability of notification in all cancer cases was discussed by others. It was advocated on the grounds that the cases once diagnosed could be followed accurately. Chief objection to it was that it might discourage some patients from presenting themselves early for diagnosis and treatment. Notification by serial number was suggested. H. H. WRIGHT, M.D.

Cancer Treatment with Radium Bearing Moulds. Kurt Wiener. Wisconsin M. J. **44:** 297–300, March 1945.

Radium-bearing moulds are mainly used in the treatment of cancers of the oral cavity and the lips; less often, of the face and external genitalia. In certain lesions at these sites, this is one of the best methods of irradiation. It should not, however, be depended on to the exclusion of other varieties of radiation therapy, and should, when indicated, be followed by deep x-ray therapy to the regional lymphatics. The author describes the construction of the moulds and gives some suggestions as to dosage. ELLWOOD W. GODFREY, M.D.

Individualization in the Management of Carcinoma of the Maxillary Sinus. Maurice F. Snitman. Ann. Otol., Rhin. & Laryng. **54:** 125–135, March 1945.

The plan of management for carcinoma of the maxillary sinus described here consists in the application of radium within the cavity as a supplementary measure to external protracted irradiation, after exposure of the antrum by conservative surgical intervention.

The location of the bone destruction permits a general division of the sinuses into two chief "malignancy areas," as suggested by Ohngren (Acta oto-laryng., supp. 19, 1933). A line, extending from the inner angle of the eye to the angle of the jaw, divides the antrum into a suprastructure and an infrastructure. Lesions above the line, situated medially, are frequently associated with nasal polyps, encroach on the meninges more readily, and tend to early lymphatic invasion. In the lateral part of the suprastructure, carcinoma has at its onset the most dormant development. It then rapidly invades the malar bone, producing the characteristic tumefaction of the external angle of the floor of the orbit. Carcinoma in the infrastructure of the antrum produces earlier symptoms, referred to the teeth.

Two chief factors enter into the consideration of a therapeutic regime: the site of the primary lesion and the presence or absence of lymphatic extension. The element of radiosensitivity of antral carcinoma can be gauged only by the responses of the cancer in general, since protracted fractionated irradiation has as yet not received sufficient trial. Lesions involving the roof of the sinus present a most unfavorable prognosis, and it is unfortunate that this area is the affected site in most cases. Adequate surgical treatment here would require a mutilating procedure with sacrifice of the eye in many cases. Good results have been reported with electrosurgery and radium implantation but there is still much to be desired. Lesions in the floor of the sinus with involvement of the hard palate and alveolar ridge are amenable to intra-oral surgical removal, followed by local radium application.

Treatment of the primary lesion is not affected by the presence of regional metastases. The management of the involved nodes follows closely the plan employed at the Memorial Hospital, New York. In brief, no prophylactic dissection or irradiation is performed. If the involved nodes are operable and the control of the primary lesion is assured, neck dissection is performed, providing certain requirements are met (Duffy: Am. J. Roentgenol. **39:** 767, 1938. Abst. in Radiology **32:** 370, 1939). If the nodes are inoperable, the patient is submitted to external irradiation supplemented by radon seed implantation.

Two proved cases of maxillary sinus carcinoma are presented, which illustrate in detail the specific radium and x-ray factors involved.

STEPHEN N. TAGER, M.D.

Necrotizing Bronchopneumonia: Its Relation to Radiation Therapy of Cancer of the Oral Cavity. Lauren V. Ackerman, H. M. Wiley, and David V. LeMone. Am. J. Roentgenol. **53:** 281–289, March 1945.

Patients with cancer of the oral cavity have an excellent chance of acquiring necrotizing bronchopneumonia (aspiration pneumonia), particularly if the lesion interferes with deglutition. Oral sepsis, malnutrition, and poorly planned radiotherapy are all contributing factors. If a patient with cancer of the oral cavity begins to lose weight rather quickly and shows a rapid pulse with a low-grade fever, necrotizing pneumonia should be considered. There is often coughing, but little or no dyspnea or sputum. The breath is not foul, as in lung abscess, nor is clubbing of the nails present. Roentgenologically there are always changes in the lower lobes; occasionally there may be involvement in the upper lobes as well. The lesions are lobular in character and of bronchial distribution. The areas of involvement will at first have a patchy to confluent cloudiness but, as the disease progresses and liquefaction of the center occurs, areas of rarefaction will make their appearance and the diagnosis will be more obvious.

Scrupulous mouth hygiene and the extraction of all teeth are indicated before starting roentgen therapy of cancer of the oral cavity. The fields should be as small as possible, with adequate filtration and protraction of irradiation over a rather long period. In treatment of the pneumonia, roentgen therapy is probably the only specific agent which may be of value. A fairly large field should be selected and small doses given for three or four days.

The authors saw 14 cases of necrotizing pneumonia, in only 2 of which recovery took place. Twelve patients died after completion of treatment for a malignant neoplasm of the oral cavity, the shortest time interval before death being three days and the longest period eleven months. CLARENCE E. WEAVER

Irradiation in Carcinoma of the Breast. Roy G. Giles. Texas State J. Med. **40:** 585–589, March 1945.

This report is based on a study of 191 unselected cases of mammary gland carcinoma. In accordance with the clinico-pathological classification suggested by Portmann (Cleveland Clin. Quart. **10:** 41, 1943), 63 cases, or 33 per cent, were placed in the inoperable Groups 3 and 4. Sixty per cent of the 122 cases from which biopsy material was obtained showed involvement of the axillary lymph nodes. Theoretically, clearly operable cases of breast cancer are those in which the malignant tissue has not extended beyond the area that can be excised. Since distant metastases may be present despite the appearance of a seemingly operable case, routine x-ray examination of the spine, pelvis, and chest is urged.

Prognosis depends upon the histologic grade of malignancy as well as on the anatomic extent of the growth.

The five-year clinical cure rate is about three times as high in those with the disease limited to the breast as in those with extension to the axilla.

Forty-eight cases in the present series showed pulmonary metastases. The tracheobronchial lymph nodes were involved in 5 cases. Parenchymal lesions were of four types: nodular in 12 cases, infiltrative in 5 cases, miliary in 2 cases; and massive, with consolidation of an entire lobe or segment thereof. There were 9 cases of pleural thickening and effusion, which are difficult to differentiate from the massive parenchymal type. Palliative roentgen therapy for pulmonary metastases often results in marked relief. One case has been under observation by the author for seven years.

Skeletal metastases were discovered in 12 of the 191 cases (25 per cent of the 63 inoperable cases). Pain was present in many instances before the lesions could be demonstrated roentgenologically. The author states that palliation may be expected in 70 per cent of the cases after application of protracted small doses of x-ray to the affected bones.

The status of roentgen castration in breast carcinoma is reviewed and the impression is gained that this procedure is of definite value especially in the presence of metastatic bone lesions. The author cites one case of his own, previously reported (Am. J. Roentgenol. **14:** 442, 1925), in which bone metastases showed a favorable response to pelvic irradiation following radical mastectomy. LESTER M. J. FREEDMAN, M.D.

Principles of Treatment of Carcinoma Cervix Uteri by Radiotherapy. Bernard Sandler. Proc. Roy. Soc. Med. **38:** 175–183, February 1945.

Sandler holds that x-ray and gamma ray treatment has hitherto rested largely on an empirical basis. In order to deliver a lethal dose to the cancer cells in the primary tumor and in potential sites of invasion the radiotherapist needs to know how the radiation acts, what a lethal dose is, and where and how such a dose shall be delivered.

Choice of wave length, dosage rate, spacing of treatments, and total dosage depend on an understanding of the behavior of both normal and malignant cells exposed to radiation. Radiation can induce either a temporary or permanent effect. There is experimental evidence that a relatively small dose (5 to 600 r) may bring about death of the cell by damage to the nucleus. The daughter cell, being deficient in nuclear content, will die. With the death of several adjacent cells, break-up of the tumor parenchyma occurs and the indirect effect of the radiation comes into play. If cells are killed too rapidly and in too great a number, the repair process will be unable to function properly and fibrosis may occur prematurely. Cytological analysis of the radiation effects at the stage while the intra- and intercellular processes are in progress is urged to control the treatment.

In a series of cases of squamous carcinoma of the cervix the author delivered 100 r by x-ray and twenty-four hours later took a biopsy specimen from the cervix. Although the tumors were histologically similar, great variation was observed in the response. In one case only 5 per cent and in another 45 per cent of the dividing chromosomes showed abnormalities. By such cytologic control, much more intelligent determination of dosage may be possible.

Cytological research is urged to determine the effectiveness in timing and spacing of single and cumulative radium insertions. Information may also be gained as to the best combinations of roentgen and gamma rays from a biological point of view.

The problem of determining the size, extent, and position in relation to the pelvis of the primary tumor and the possible paths of invasion is complicated by the fact that only a portion of the tumor is usually accessible to vaginal measurement. The volume to be treated includes not less than the true pelvis and, in many cases, more, since the iliac nodes have been demonstrated at times to lie above the brim of the pelvis. The function of x-ray therapy is to reach those sites not adequately treated by radium. The author objects to the usual employment of symmetrical x-ray fields about the mid-line, because the radium lethal isodose level may be symmetrical but not about the mid-line, or may not be symmetrical in any plane. In many methods used, the most penetrating portion of the beam is not directed at the pelvic wall, where the need is greatest.

The importance of obtaining proper spatial distribution of dosage is stressed. Mayneord has devised methods of ascertaining the three-dimensional distribution from radium sources and of expressing results as isodose charts or as models. With this knowledge and accurate determination of the position of the applicators in relation to the pelvis, x-ray therapy can be delivered to the portions of the pelvis where it is most needed. Complete co-operation between the gynecologist and radiotherapist is essential. H. H. WRIGHT, M.D.

Effect of Deep X-Rays on the Peritoneal Metastases of an Ovarian Carcinoma. James Watt. Proc. Roy. Soc. Med. **38:** 175–183, February 1945.

Watt reports the case of a married woman, age not stated, who presented a history of colicky lower abdominal pain of three weeks' duration, and on examination showed a firm mass arising from the pelvis and reaching almost to the umbilicus. At laparotomy the peritoneal cavity contained some free fluid; secondary growths were present on the walls of the cavity and the omentum; the pelvis contained a mass arising from the left ovary and spreading directly onto the pelvic colon. Biopsy of a nodule from the omentum showed spheroidal-cell carcinoma. A course of deep x-ray therapy was given covering the whole peritoneal cavity (dosage and physical factors not mentioned). Six months later the patient appeared in good health, was gaining weight, and no abdominal mass could be detected. Eleven months following laparotomy, a cystic swelling was found, arising from the pelvis. Exploration at this time showed no secondary deposits in the peritoneal cavity. The right ovary appeared normal and was left in place. The left ovary and its cystic mass were removed. Its walls contained nodules which on section showed papilliferous carcinoma with large areas of necrosis.

The author suggests that following x-ray therapy in such cases, if there is evidence of marked regression, the abdomen should be opened to determine whether the primary growth can be removed.

H. H. WRIGHT, M.D.

Relationship of Epithelial Buds to Carcinoma of the Pelvis of the Kidney, Ureter and Bladder. Albert E. Bothe. J. Urol. **53:** 451–458, March 1945.

The author briefly reviews the literature concerning the occurrence of epithelial buds and nests within the

urinary tract. He has himself shown epithelial cell nests to be present in 38 of 54 consecutive autopsy cases. In no case in this series was there any neoplastic change associated with urinary tract buds or cell nests even though malignant tumors of various types were found in 14 of the 38 cases.

Twelve surgical specimens were also studied, all showing carcinoma of some portion of the urinary tract. Examination of tissues adjacent to and distant from the primary carcinoma, which did not appear malignant, showed subcutaneous hyperemia with associated round-cell infiltration, sometimes with digitation of epithelial cells into the subepithelial supporting tissue. Other areas in the subcutaneous tissue showed islands of epithelial cells, identical with the buds found in the necropsy material. This was so in all the surgical specimens.

The author mentions the possibility that these immature buds may be the tissue susceptible to activation upon a systemic chemical basis and states that x-radiation may render these buds inactive. He sites two of four patients all with multiple small papillomas of the bladder who were treated by x-ray followed by transurethral desiccation. The other two patients were treated by desiccation alone. The first two patients have never had a recurrence, while the latter two have had repeated recurrences. Photomicrographs and drawings are included.

N. P. SALNER, M.D

Carcinoma of the Prostate. Harold J. Ham. M. J. Australia **1:** 168–169, Feb. 17, 1945.

Ham admits that results from radiotherapy in carcinoma of the prostate have been discouraging, particularly when one is considering cure or length of survival after treatment. He considers it a valuable adjunct in treatment, however, both in the control of the primary growth and relief of pain.

Between 1933 and 1941, inclusive, 49 patients were treated in the x-ray department, Sydney Hospital (Australia). These received various combinations of surgery, x-ray, and radium. The group receiving endoscopic resection combined with deep x-ray therapy gave the best results.

The author believes that improved technic, with multiple small fields carefully localized to the prostatic region and use of higher voltages, may offer considerably better results in control of the primary tumor

The principal value of x-ray therapy in bone metastases is in relief of pain, definite palliation being reported in more than two-thirds of the cases treated. Lymph-node metastases may sometimes prove radiosensitive.

Mention is made of reports of several writers on the effect of irradiation of the testis. In view of Munger's encouraging report, the author suggests further trial of irradiation of the testes, using larger doses.

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EFFECTS OF RADIATION

Myelomalacia of the Cervical Portion of the Spinal Cord, Probably the Result of Roentgen Therapy. Lewis D. Stevenson and Robert E. Eckhardt. Arch. Path. **39:** 109–112, February 1945.

A man with lymphoepithelioma of the nasopharynx was given roentgen therapy (200 kv., 50 ma.) through five portals from October 1941 to January 1942, as follows:

Intraoral
2.5 cm. around
40 cm. target-skin distance
0.5 Cu + 1 Al filter
Total dosage 4,000 r (10 treatments)
Right temporal
6 cm. around
50 cm. target-skin distance
1 Cu + 1 Al
Total dosage 4,000 r (16 treatments)
Left temporal: Same as right
Right cervical
13 × 6 cm.
50 cm. target-skin distance
1 Cu + 1 Al
Total dosage 4,000 r (16 treatments)
Left cervical
12 × 9 cm.
50 cm. target skin distance
1 Cu + 1 Al
Total dosage 5,750 r (23 treatments)

The lesions disappeared completely following this treatment. In November 1942 a necrotic area developed in the mid-line on the posterior part of the hard palate; this responded to local irrigations. In September 1943, a 2-cm. node was found in the soft tissues over the insertion of the right sternocleidomastoid muscle. To this node were given 4,500 r (15 × 300 r) with 200 kv., 15 ma., 50 cm. target-skin distance, 0.5 Cu and 1 mm. Al filtration. The node disappeared, and an ulcer over the site healed promptly. In November the patient began to notice stiffness and clumsiness of the left arm and the left leg. He complained of constipation and on three occasions urinated involuntarily. He also became impotent. Physical examination disclosed nothing remarkable except for induration of the tissues of the neck in the region of the previous irradiation. Roentgenography of the chest revealed only apical pleural thickening and mild emphysema. Neurologic examination showed hyperreflexia of the left side, left finger stretch, absence of abdominal reflexes on the left, and a Babinski sign on that side. There was motor weakness of the left side, not including the face. Re-examination three days later showed that a finger stretch and a Babinski sign had appeared on the right side, that sensation to pinprick was lost below the third thoracic segment bilaterally. The sensation of heat was lost below the fourth cervical segment bilaterally, but sensation of touch was normal throughout.

It was thought that there was a rapidly expanding intramedullary lesion in the region of the fourth cervical segment, possibly a metastasis, and a cervical laminectomy was performed. The cord and the dura from the sixth cervical vertebra to the foramen magnum appeared normal, with no evidence of epidural or intramedullary growth and no apparent vascular changes. Following operation, the patient's symptoms progressed to include both sides, and complete urinary incontinence developed. Since it was thought that the laminectomy had ruled out late radiation fibrosis and adhesive arachnoiditis of the cord, a course of

roentgen therapy was directed to the cervical cord for the possible effect on any undisclosed metastasis. Through an 8-cm. portal in the posterior cervical region 3,300 r (11 × 300 r), with 200 kv., 15 ma. at a 50 cm. target-skin distance and with a filter of 0.5 mm. Cu and 1 mm. Al, was given. Despite this, the patient's condition became progressively worse and he died in February 1944, apparently of respiratory paralysis. Autopsy revealed myelomalacia of the cervical part of the cord, in the vicinity of which many thickened arterioles with fibrous walls could be seen. The vertebral marrow was infiltrated in large areas by epithelial cells with collections of lymphocytes, in conformity with the diagnosis of lymphoepithelioma.

This case shows an unusual end-result of radiation therapy. It is calculated that this patient received 6,000 to 8,000 r at the level of the spinal cord. The possibility of such a reaction should be kept in mind when roentgen therapy is directed to the neck.

The Effects of Roentgen Radiation on the Thymonucleic Acid Content of Transplantable Mammary Carcinomas. Robert E. Stowell. Cancer Research **5:** 169–178, March 1945.

The relative thymonucleic acid content of transplantable mammary carcinomas in rats and mice was measured by means of the Feulgen reaction and a special microphotometric apparatus. The tumors on one side of the animal were irradiated while those on the other side were protected by lead shielding and used as controls. The dosage, which varied up to 4,000 r, was insufficient to produce definite regression of the tumors, but growth retardation was evident in many instances.

The 6 rat tumors receiving 4,000 r showed a mean decrease of 13 per cent and of 5 per cent in their content of thymonucleic acid per area and per cell, respectively. The effects of 2,000 r on 6 rat tumors were more variable and less significant. The 16 irradiated mouse tumors showed a mean decrease in thymonucleic acid content per area and per cell of 5 and 3 per cent, respectively. In 9 of the 16 the decrease in thymonucleic acid per area was statistically significant, and in 4 of these the decrease per cell was significant.

The results of these experiments would support a hypothesis that roentgen radiation may alter the molecular structure of vital substances within the nucleus and produce a disturbance of the nucleoproteins, which in some instances is followed by death of the cell. Mitchell (Brit. J. Exper. Path. **23:** 285, 1942) found that ribonucleic acids are increased in the cytoplasm following irradiation. The present observations, which show a decrease in desoxyribonucleic acid in irradiated cells, suggest that one of the most important intracellular effects of roentgen radiation is the production of an upset in the normal balance and metabolism of both types of nucleic acids.

Effect of Colchicine and X-Rays on Onion Root Tips. Michael Levine. Cancer Research **5:** 107–119, February 1945.

The author presents a comprehensive review of the literature dealing with the effect of colchicine ($C_{22}H_{25}NO_6$) on plant and animal tissues. When applied in small doses, it has been shown to produce a retarding effect on mitosis in the cells of either growing vegetative or germinal tissue. In tumors, the metaphase stage of the active peripheral cells is prolongd so that the number of cells in division—and therefore vulnerable to the effect of radiation—is increased. Studies of the combined effect of colchicine and x-rays on tumor growth have, however, been inconclusive. In view of this the author conceived the idea of treating with colchicine and x-rays a "simple fundamental tissue, meristematic in nature and responsive to both agents," in the hope that such a study would serve as a forerunner of a similar investigation with animal tumors of cytogenic homogeneity. As his simple fundamental tissue he chose root tips of the common onion (*Allium cepa*). The bulbs were kept in a solution of 0.01 per cent colchicine in tap water and after certain intervals were exposed to doses of 900, 1,500, or 3,000 r (200 kv., 25 ma., 0.5 mm. Cu + 3 mm. Al, 42 to 67 cm. distance, 95 to 133 r per minute). Untreated bulbs and bulbs treated only with colchicine or only with x-rays served as controls.

The effect of exposure to colchicine for more than 48 hours, coupled with 900 r, prevented growth of the root tip; 48 hours' exposure to colchicine with 1,500 r induced similar results. With the shorter exposures to colchicine (18, 24, 36 hours) and 1,500 r, the hypertrophied tips produced only a limited growth, which became arrested five to seven days after their return to water. Exposures of 48 hours combined with 3,000 r prevented further growth.

Irradiation with 900 r, 1,500 r, and 3,000 r impaired growth; the time for recovery was proportionately less than that required for the combined effects of colchicine and x-rays.

The leaves of bulbs colchicinized and irradiated with 1,500 r or 3,000 r were retarded in subsequent growth as compared with those treated by x-rays only. Bulbs colchicinized only showed leaf growth approximately equal to the untreated plants. The combinations of (*a*) an exposure of 900 r and treatment with colchicine for less than 72 hours and (*b*) 1,500 r and 48 hours of colchicine are most effective in arresting growth of fundamental plant tissues such as the root tip of the onion.